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ABSTRACT

This training manual provides information needed to meet the minimum EPA standards for certification as a commercial applicator of pesticides in the general and household pest control category. The text discusses invertebrate pests that effect health, stored products, grain, fabric, or the household; and vertebrate pests such as rats, mice, and birds. A study guide with sample and study questions is included. (CS)

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Pesticide Applicator Training Manual

Category 7A

GENERAL AND HOUSEHOLD PEST CONTROL

RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

SE 024 677

PESTICIDE APPLICATOR TRAINING MANUAL
CATEGORY 7A

General and Household Pest Control
for
New Jersey

A Training Program for the Certification
of Commercial Pesticide Applicators

by
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INTRODUCTION

Besides the proper and safe use of pesticides, correct identification of pests and a thorough knowledge of their biology, habits, and habitats are essential to any successful control program. Insects, rodents, and related animals which are institutional, industrial, residential, structural, and health related pests are considered in this category. These pests can be controlled by a number of methods; pesticides are not the only or perhaps the best method of control in all situations. Where applicable, the use of proper sanitation, natural enemies, quality water management, and mechanical methods such as traps or screens, should be part of any sound control program. Many of these procedures may prevent the build-up of large numbers of pests and thus be less hazardous to man and the environment in the long run. Combinations of several control methods, including pesticides, in an "integrated control" program will give the best results. This approach may take longer and be more expensive at first, but eventually may prove less costly than an all-pesticide program. In emergency situations where pests are of public health concern and rapid reduction of pest populations is necessary, the use of pesticides alone may be the best approach. However, their sole use will give only temporary relief.

People involved in pest control should be aware of alternate control methods and their proper use. Effective and economical control programs must also include adequate surveys and inspections. An essential to any control program is knowing what the pest is and how many there are. When necessary, such organizations as the Cooperative Extension Service, State

Pesticide Regulatory Office, Public Health agencies, Medical and Veterinary agencies, and Wildlife agencies should be consulted.

Remember, certification can be the stamp of professionalism in your work!

INVERTEBRATE PESTS: HOUSEHOLD

COCKROACHES

General:

Cockroaches are insects which are familiar to many people. Some are particularly suited to hiding in cracks and crevices of man-made structures and are capable of surviving quite well on scraps of food associated with the presence of man. Of the 4000 kinds of cockroaches known throughout the world, only 4 species are of economic importance to man in New Jersey.

The chief economic importance of cockroaches concerns the large quantities of foodstuffs they contaminate. Cockroaches normally occur and thrive in unsanitary conditions but, because they readily spread through adjoining buildings, even "spotless" establishments may become infested.

Because of their particular "fondness" for filthy places, cockroaches are quite capable of indirectly transmitting a number of diseases. They may crawl over or feed upon filth, excrement, garbage, and sewage and then visit man's food and food areas. As a result, cockroaches may spread the disease organisms which cause diarrhea, food poisoning, dysentery, and typhoid.

The bodies of cockroaches are flattened from top to bottom and are somewhat oval in shape. Most adult cockroaches have two pairs of wings but some have only partially developed wings or none. Many cockroaches can fly but are more commonly seen running on their long, well-developed, spiny legs. Cockroaches develop through three distinct life stages (egg, nymph, and adult). This type of development is called gradual metamorphosis. The egg case which

sometimes protrudes from the tip of the abdomen of the female, contains a number of eggs. The small nymphs which hatch resemble the adults but are wingless. The nymphs grow by a series of molts until finally the mature adults appear at the final molt.

Where infestations are small, live cockroaches may never be seen because they are most active at night (nocturnal). However, the presence of cockroaches may be determined by other means. Cockroaches have a characteristic "musty" odor and this odor may be strong in places they often visit. Other signs of cockroach infestations may include finding full or empty egg cases, excrement, and occassionally the shed skins of the nymphs. The excrement left by the smaller species may appear as greasy smudges while the excrement of the larger species resembles mouse droppings.

THE AMERICAN COCKROACH

Description and Biology:

Of the common and economically important cockroaches in New Jersey, the American cockroach is the largest reaching $1\frac{1}{2}$ inches in length. This species is reddish-brown in color and has a yellowish boarder around the shield-like area (pronotum) immediately behind the head. Although capable of short, gliding flights, the American cockroach will normally only run. The droppings of this cockroach resemble those of mice but are blunt on both ends and have a number of light colored ridges running

Fig. 1. American Cockroach

from end to end. Mouse droppings lack these ridges and are tapered on one end. The egg cases of the American cockroach are chestnut-brown in color, about 1/3 of an inch long, and are usually dropped randomly by the female. The adults may live well over a year and during this time the female will produce about 60 egg capsules, each containing around 15 eggs. After hatching, the nymphs molt at least 10 times, requiring about 1 year. The life cycle (egg through adult) of this species may take over 2 years to complete.

Habits and Habitats:

In warmer parts of the United States, the American cockroach may be found outdoors but in New Jersey, it lives indoors. T is species prefers warm, moist places and is most often found in crawl spaces, basements, boiler rooms, steam tunnels, garbage dumps, and certain areas of sewers. The American cockroach will feed on decaying organic matter, starchy material such as book bindings and labels, and some fabrics. It can withstand starvation for several months and survive up to a month without water.

THE ORIENTAL COCKROACH

Description and Biology:

The Oriental cockroach is the other large cockroach species found in New Jersey. It is 1-1$\frac{1}{4}$ inches in length and is dark brown to black in color. The adult male Oriental cockroach has short, blunt wings while the adult female has only barely visible wing pads. Neither adult of this species can fly. The Oriental cockroach is somewhat

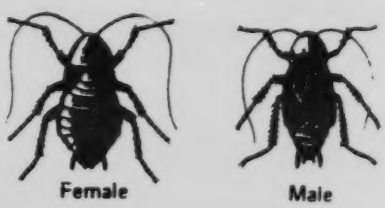


Fig. 2. Oriental Cockroach

seasonal with the adult population reaching its peak during the spring. Adults live about 3-4 months and during this period, the female will randomly deposit about 15 egg capsules, each containing about 15 eggs. The life cycle may take well over a year to complete with the nymphs undergoing at least 7 molts.

Habits and Habitats:

The Oriental cockroach is commonly found indoors around water pipes, sewage lines, damp basements, under refrigeration units, and in garbage areas. The Oriental cockroach will feed on virtually any type of filth or organic matter. Like the American cockroach, the Oriental cockroach can live for extended periods without food, but has a much greater moisture requirement and will die within 2 weeks without water.

THE GERMAN COCKROACH

Description and Biology:

The German cockroach is about $\frac{1}{2}$ inch long and light to medium brown in color. Both males and females have fully developed wings but rarely fly. The adults have two dark bands on the pronotum which continue lengthwise down the abdomen. The nymphs are dark brown to black in color with a single light-colored stripe running lengthwise down the back. The adult German cockroach lives approximately 6 months. During her lifetime, the female will produce about 7 egg capsules, each containing around 40 eggs. Unlike the other cockroaches, the female German cockroach carries the egg capsule with her until just before the eggs hatch. This insures a higher

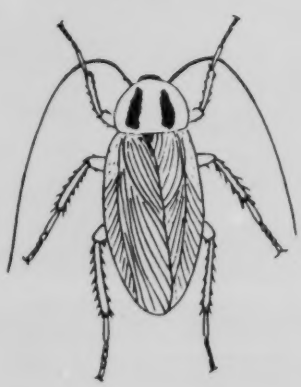


Fig. 3. German Cockroach

rate of survival for her offspring. The nymphs go through 5-7 molts requiring about two months to complete. Because of the high and rapid reproductive rate and the increased survival rate, large infestations of German cockroaches may build up in a short time.

Habits and Habitats:

German cockroaches prefer moist situations and are commonly found in bathrooms, kitchens, and food areas of homes, bars, hotels, and restaurants. They are most active at night but may be seen during the day. This cockroach may be found outdoors in warm weather and is usually associated with garbage areas. Although the German cockroach will feed on almost anything, fermented foods are preferred. Adults may live up to a month without food providing water is available but nymphs soon die without either water or food.

THE BROWN-BANDED COCKROACH

Description and Biology:

At first glance, the brown-banded cockroach looks like the German cockroach. The brown-banded cockroach is tan to medium brown in color. The wings of the male extend the length of the body but the wings of the female are relatively short. This species has two tan to yellow stripes running across its body at the point where the wings attach to the body. These markings are more distinct in the wingless nymphs. During her 4 month adult life, the female will produce 10 egg cases, each containing an average of 15 eggs. The female does not randomly drop the

Fig. 4. Brown-banded Cockroach

egg capsules but rather glues them to various objects. The nymphs will molt 7-9 times over a period of 6 months to over a year.

Habits and Habitats:

The brown-banded cockroach is often considered the most difficult to control since it moves to all areas of a building or home. Unlike the other species of cockroaches the brown-banded cockroach can withstand a fairly dry environment. This species is seldom found in kitchens or bathrooms and is not generally a pest of food establishments. The adults are fairly good fliers and are often seen on ceilings.

WASPS, BEES, ANTS

Introduction:

These insects form a natural grouping primarily because of one simple fact: they all care or provide for their young by establishing a nest or center to which they bring food for the young or larvae. Other insects place their eggs on or near the food material; ants, wasps and bees do the reverse. It is this simple fact which has made possible the evolution of "social" or colony-forming species, some of which are of great importance to man.

They share the same type of life history involving egg, larva, pupa and adult. In the "solitary" or non-colony forming species, the adult may be either a male or a female. In the "social" or colony-forming species, the egg-laying female or "queen" can elect to produce eggs resulting only in females, thus exercising a true sex-control over her offspring. Usually these females cannot mate, yet have all the "maternal" instincts of gathering

food, feeding the young and defending the nest. They have long been called "workers", which describes them very well.

Medical Importance of Wasps, Bees, and Ants:

Most wasps, ants, or bees will not sting unless the nest is threatened or the individual is molested. Stinging is more likely to occur on cloudy or cool days when the individuals are not foraging.

In general, the stings of wasps, bees, and ants may cause localized pain, irritation, redness and swelling. Usually, these symptoms last only a short time. In nonsensitized people several hundred to several thousand stings would probably be required to produce enough venom to cause death. However, in highly sensitive persons, shock or death may result from a single sting. In susceptible people symptoms may range from tiredness, anxiety, chest constriction, and wheezing to a drop in blood pressure, collapse, and unconsciousness. Consequently, stings of wasps, ants, and bees become a serious medical problem to highly sensitive individuals.

WASPS

General:

This group contains such familiar pests as hornets, mud-daubers, yellow-jackets, and cicada killers. All of these wasps have two pairs of wings and a "wasp-waist" or constricted abdomen (petiole). Unlike the ants, no lobes or nodes are found on the petiole. This feature may be useful in separating winged ants and certain wasps. Wasps develop into adults through egg, larval, and pupal stages (complete metamorphosis). The females of most wasps can sting.

The habits and behavior of wasps are varied. Some wasps are "social", that is, the overwintering fertilized queen lays and cares for the first brood. The resulting adults are unfertile females which take over the duties of foraging, expanding the nest, caring for new broods, and defense of the nest. Thus, a family unit or colony is created. The solitary wasps do not have such a family unit. The female, after building an individual cell or nest, lays an egg and provisions the nest with an adequate supply of larval food. No further care is given to the offspring. The individual offspring so produced will be either a male or a reproducing female.

The Social Wasps:

Most of the social wasps belong to one family of wasps (Vespidae) and are commonly known as vespid wasps. Although wasp nests differ according to species, they are usually built of a kind of paper-like material. Plant fibers are chewed and mixed with salvia to make the nesting material. In warmer regions of the United States, these nests may be used for several years but in colder areas such as New Jersey, the workers and males cannot survive the winter and the nest is abandoned.

In the spring the overwintering females select a nesting site and lay eggs for the first generation. Throughout the spring and summer months, the nest is enlarged as the number of individuals increases. All these individuals are sterile females and direct descendants of the original queen. Only at the last generation of the year does the queen produce males and fertile females. After this generation mates, the males die and the females seek suitable places to spend the winter. With the arrival of spring, the female constructs a small

nest, lays her eggs, and rears the first brood of workers.

Among the so-called paper wasps are several familiar species commonly known as "yellow-jackets". Yellow-jackets are medium sized ($\frac{1}{2}$ of an inch long) wasps with conspicuous yellow and black stripes. Normally, they nest in the ground and produce colonies with as many as several thousand individuals by late summer. Yellow-jackets will occasionally nest under eaves of houses and similar locations but such nests are usually much smaller. The yellow-jackets are aggressive and readily sting. Another group of paper wasps closely related to the yellow-jackets are the hornets. Hornets are generally larger, reaching an inch in length, brownish or black in color, and noticeably marked with yellow or white cross-bands. This group of wasps which contains the giant hornet and bald-faced hornet normally nest in trees. The nests may be quite large and resemble a football in both size and shape. These nests may contain several thousand individuals.

Fig. 5. Yellow Jacket

Fig. 6. Bald-faced Hornet

The third group of common social wasps belong to the genus Polistes. The Polistes wasps are medium-size and brown to reddish-brown in color.

These wasps build small, inverted, single layered nests which rarely contain more than 50 individuals. These nests are commonly constructed in sheltered places such as under eaves or overhangs of buildings. These wasps are also aggressive and capable of inflicting a painful sting.

Fig. 7. Polistes

By whatever method used, social wasps are best controlled at night when all the workers are within the nest and are generally less aggressive.

Solitary Wasps:

Among this group are wasps commonly known as "mud-daubers" and "digger wasps". Most wasps in this group belong to one family and are thus often referred to as "sphecid" wasps. Sphecid wasps construct a variety of nests. No unfertile females or workers exist in this group. After mating, the female constructs one or several cells which she provisions with suitable larval food. An egg is laid in each cell and the cell is sealed. The hatching larvae are thus provided with all the necessary food for development. The female gives no future care to the offspring.

Fig. 8. Mud Dauber

The black-and-yellow mud-dauber and the blue mud-dauber are common species in this group. The females build one or several mud cells which they provision with paralyzed spiders, lay an egg, and

seal the nest. Generally, there are two generations per year and the individuals overwinter as full grown larvae. The adult black-and-yellow mud-dauber is commonly found around moist places such as mud puddles where mud is gathered for nest building. The blue mud-dauber does not build nests but rather uses those made by the black-and-yellow mud-dauber. Because of this behavior, these species may become pests in similar areas.

Fig. 9. Cicada Killer

The cicada-killer is a large brown wasp with cream-colored markings on the abdomen. This species receives its name because it provisions its nests with cicadas. The nests are commonly constructed in lawns and similar landscaped areas. Cicada-killers are usually encountered in July or August when overwintering larvae pupate and emerge as adults. Large populations of these wasps may result in serious injury to lawns due to their nesting activity. This wasp is not aggressive and usually will sting only if strongly provoked.

Another group of ground-dwelling wasps are the "velvet-ants" or "mutillid wasps". The females are wingless, are covered with numerous short hairs giving them a "velvet" appearance, and are often bright red to yellow. Males are winged and larger. The velvet-ants are normally found in open, dry areas and are parasites of the larvae and pupae

Fig. 10. Velvet Ant

of wasps, bees, beetles, and flies. The females can deliver a very painful sting. Velvet-ants are more prevalent in southern New Jersey where sandy soils are common.

BEES

General:

The honey bees, bumble bees, and carpenter bees belong to the same family, the Apidae. The honey bees and bumble bees are social and among the most beneficial of all insects. In addition to producing honey and wax, they are pollinators of many crops and other plants. The carpenter bee is a "solitary" bee and not considered beneficial because of its wood boring behavior.

HONEY BEES

Description and Biology:

Honey bee workers range from 1/2 to 3/4 of an inch in length and are densely covered with light colored hairs. The color of the honey bee varies from yellowish-brown to dark brown or black. There are 3 castes: queen, drone (male) and worker.

Fig. 11. Honey Bees

From left: Worker, queen, and drone bees.

During late spring or early summer, a healthy colony will become overcrowded. At this time, virgin queens and drones are produced and embark on a "marriage flight". The mated queen then returns to the original colony to

take over the reproductive duties of that colony. The "old" or original queen and a group of workers leave the colony, swarm, and eventually locate a new nesting site. A mature hive or nest may contain up to 50,000 individuals. Unlike the social wasps, the honey bee colony remains intact throughout the winter. The honey provides the food during the winter. In late winter, accelerated production of workers begins in anticipation of spring blossoms.

Habits and Habitats:

The honey bee normally nests in hollow trees but for centuries has been kept by man in hives. When the honey bee nests in wall voids of buildings, it is a pest and control of such a colony is relatively simple. Success depends on the timing. The destruction of the colony should be accomplished in March, when the honey supplies are low. Elimination of the bees in the fall results in problems when the large honey stores become rancid, ferment and stain walls. Remaining honey stores may become infested with wax moths or dermestid beetles and present an additional problem.

Another problem from honey bee activity near homes or recreational areas is swarming. Swarming bees however, are full of honey and are thus mild-tempered and less likely to sting. If left alone the swarms will disappear in several days. Bees have a high water requirement, especially during the hot summer months. As a result, they may become pests around homes by being attracted to swimming pools or bird baths. By temporarily eliminating that water supply and providing another one at a considerable distance away, the bees may become accustomed to the new supply and the bird bath or swimming pool may be refilled and used without further annoyance.

Remember, bees are very beneficial insects and should not be destroyed unnecessarily.

BUMBLE BEES

Description and Biology:

Bumble bees are large, robust bees, black and yellow in color, and measure about 3/4 of an inch or so in length.

The biology of the bumble bee is similar to that of the social wasps. The overwintering fertilized female locates a suitable nesting site usually in the soil and rears her first brood which becomes sterile female workers. These worker bees take over the duties of the colony and only at the last generations of the year are the males and fertile females produced. After mating, the female seeks an overwintering site such as behind loose bark or in a hollow tree and the cycle is complete.

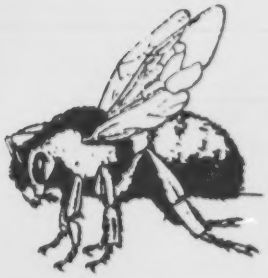


Fig. 12. Bumble Bee

Habits and Habitats:

The bumble bees are ground nesting social bees. They are important pollinators and only become pests when they nest in buildings. Their large size and foraging behavior may cause alarm in some people but bumble bees rarely sting unless provoked.

CARPENTER BEES

Description and Biology:

Carpenter bees are closely related to bumble bees but can be separated

in that the entire abdomen of the carpenter bee is shiny black while that of the bumble bee is partially covered with yellow hairs.

The mated female chews or "drills" about a $\frac{1}{2}$ inch diameter hole in seasoned wood. This cavity is separated into several cells by secreted wax, each of which is provisioned with pollen and honey. As each cell is provisioned, the female lays an egg in the cell and seals it with wax. The wood is not used for food. The female continually repeats this process for about a month until death. The hatched larvae feed on the provided food, pupate, and remain in that state over the winter. The following spring, the pupae become adult males or females and emerge from the holes made by the parent bee.

Habits and Habitats:

The carpenter bee is a solitary bee which builds its nests in various types of wood ranging from trees and fence posts to rafters, siding, gutters, and beams of houses. When man-made structures are involved, the carpenter bee is a pest causing damage to these structures. Heavy nesting activity in a limited area can cause structural weakening. The carpenter bee has the ability to sting but seldom does.

ANTS

General:

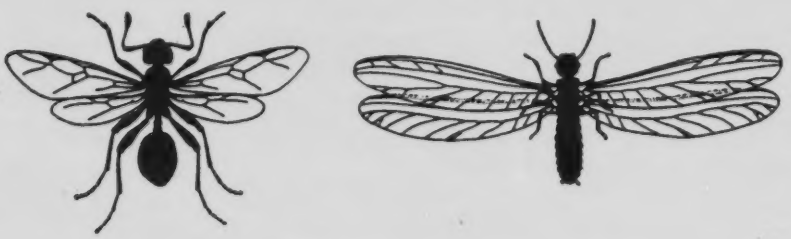
Ants of many kinds are found throughout the world in many different habitats. They are one of the most advanced and successful insect groups. Ants are social insects and like the bees and termites, the colonies contain several different types or castes of individuals. The castes include workers,

males, and queens. Ants have a high moisture requirement and nest where moisture is readily available or may travel considerable distances to obtain it.

Ants are generally considered beneficial insects but may become annoying to man when they invade homes during foraging. Some species nest in wood and may do structural damage. Some ants can bite or deliver a painful sting. This sting usually results in local swelling but in highly sensitive persons, an allergic reaction results.

Although their appearance is familiar to many people, occasionally they are mistaken for several other insect groups. Most often, the winged reproductives of an ant colony are confused with wasps or even swarming termites. Ants may be easily distinguished from termites because the first one or two segments of the abdomen (petiole) of the ant are narrow or constricted and the abdomen of the termite is not. The antennae of the termite are straight while those of the ant are bent or "elbowed". In winged forms, the two pair of wings of termites are of equal length while the hind wings of ants are smaller and shaped differently than the forewings.

Fig. 13. A Comparison of Ant and Termite Swarmers



Winged ant. **Termite.**

Distinguishing flying ants from wasps is a little more difficult. Wasps also have the constricted abdomen or "wasp-waist" but ants possess one or two

upright lobes (nodes) on the petiole; these nodes are absent in wasps.

Once a colony is mature or very large, male and female winged reproductives are produced which may mate in the nest or during swarming. Ants swarm at various times throughout the year. After mating, the male soon dies. The fertilized female or queen seeks a suitable nesting place and deposits a small batch of eggs. All ants exhibit complete metamorphosis. The hatched larvae are cared for by the female until they pupate and finally emerge as adults. Development from egg to adult usually takes about two months but varies with different species and climatic conditions. These new individuals are wingless, sterile female workers. The workers of some species may be quite different in size or even appearance. These workers then take over the tasks of foraging for food, expanding the size of the nest, and caring for the next group of larvae.

The ant colony remains intact through the winter by hibernating. However, if a colony occurs indoors, the individuals may remain active all year around.

CARPENTER ANTS

In New Jersey, the black carpenter ant and red carpenter ant are the two species of economic importance. The workers of the black carpenter ants are shiny black in appearance and about $\frac{1}{4}$ to $\frac{1}{2}$ inch in length. Red carpenter ants are similar in size but the thorax and part of the abdomen are reddish-brown. The carpenter ants normally nest in wood and when this wood is part of a building, their excavations may cause structural damage. Usually, the wood they attack has been previously damaged by water and has begun to decay.

Ant damage to wood is often confused with termite damage. Unlike those of termites, the galleries of carpenter ants are clean and contain no soil or fecal pellets. Carpenter ants do not use wood for food but discard the wood fragments and feed on sugary liquids of trees and plants and on the "honey-dew" of some plant feeding insects. Carpenter ants show a particular fondness for sweet foods.

Fig. 14. The Black Carpenter Ant

The colonies of this species are comparatively small. During the winter individuals within the colony hibernate. Thus, these ants are not pests during the winter unless the colony is located in a heated building.

THIEF ANT

These common ants are quite small (1/16 inch in length) and yellow in color. This species is highly predaceous on a variety of insects including other ants. The thief ant prefers to nest in the ground but may become an indoor pest during foraging. Scraps of meat and fat or grease are preferred foods. The colony hibernates through the winter.

PHARAOH'S ANT

This species normally exists in warmer climates but may become a pest in New Jersey by colonizing in wall voids of heated buildings. Pharaoh's ant closely resembles the thief ant. The antennal club of Pharaoh's ant is 3-segmented while the club of the thief ant is 2-segmented. Colonies of Pharaoh's ant may be quite large and have several queens. Like thief ants, Pharaoh's ant

prefers foods containing protein rather than sweet foods.

LINED ACROBAT ANT

This ant is about 1/8 of an inch in length and can be identified by the pointed tip of the abdomen. Colonies normally occur in or near damp wood. When associated with buildings, nesting commonly occurs beneath window sills or roof gutters where faulty drainage results in damp conditions. Occasionally, foraging occurs in kitchens. Structural damage to wood done by this species is not as extensive as the damage done by carpenter ants.

PAVEMENT ANT

The brown and black workers of this species are small and about 1/8 of an inch long. The pavement ant is the most common home-invading ant in New Jersey. Colonies may be established outside or inside and are often associated with foundation walls and concrete slabs. Colonies occurring indoors may be active throughout the winter. Swarms of winged reproductives often occur within buildings.

LITTLE BLACK ANT

The little black ant is a very small (1/12 of an inch long), black species which occurs primarily in southern New Jersey or other parts of the state where sandy soils predominate. This ant does not normally nest within homes but may become a pest in kitchens during foraging.

YELLOW ANTS

The yellow ants comprise two species, the larger yellow ant and the smaller yellow ant. Both species are about 1/6 of an inch long and yellow or reddish-yellow in color. These ants often nest in soil near foundation walls

of homes where they feed on the honeydew produced by several root-infesting insects and do not normally enter homes to obtain food. However, since they commonly swarm during the same time of the year, yellow ants are often confused with termites and as a result may alarm home owners. Yellow ants do not cause structural damage and much unnecessary concern and possible expense may be eliminated by the proper identification of the swarming pests.

INVERTEBRATE PESTS: HEALTH RELATED

FLIES

All flies belong to the order of insects called Diptera. They may be separated from all other insects in that they have only one pair of wings. All flies exhibit complete metamorphosis (egg, larva, pupa, and adult). Flies become a problem to man primarily through the nuisance created by their presence and/or biting behavior, but some are involved in disease transmission. Before any preventative measures or control attempts are made, identification of the pest and an understanding of its biology, habitats, and behavior is essential.

HOUSE FLY AND ITS RELATIVES

General:

This group contains three families of closely related flies and include the Sarcophagidae (flesh flies), the Calliphoridae (blow flies), and the Muscidae (house flies, lesser house flies, face flies, stable flies, and false stable flies). All these flies will, at least to some extent, enter human dwellings. With the

exception of the stable fly (which will be discussed with the blood-sucking flies), the house fly and its relatives have sponging mouthparts and do not take blood.

Description:

House Fly - House flies are gray, robust, medium-sized flies ranging from $\frac{1}{4}$ to $\frac{1}{2}$ inch long. The thorax has four dark-colored stripes running lengthwise down the body and the abdomen is somewhat lighter in color. The wormlike larvae (maggots) are cream-colored, pointed at the front end, and grow to about $\frac{1}{2}$ inch long. Pupae are spindle-shaped and reddish-brown.

Fig. 15. House Fly

Face Fly - This species closely resembles the house fly and correct identification of the adults usually requires an expert. Face fly maggots are similar to house fly maggots but are more yellowish. Pupae are off-white in color.

Lesser or Little House Fly - Members of this species are slightly smaller and more slender than either the house fly or face fly. They are gray in color with the abdomen of the males appearing black with yellowish markings near the thorax. Larvae are brown and flattened with spine-like projections along the sides of

Fig. 16. Lesser House Fly

the body. Pupae are similar in appearance to the larvae.

False Stable Fly - This species is larger and more robust than the house fly. They are gray in color and the posterior part of the top of the thorax is yellow to pale red. The larvae and pupae are similar to those of the house fly but slightly larger.

Fig. 17. False Stable Fly

Biology:

The biology of the house fly and its relatives is similar and will be discussed in general terms with important differences between species being noted.

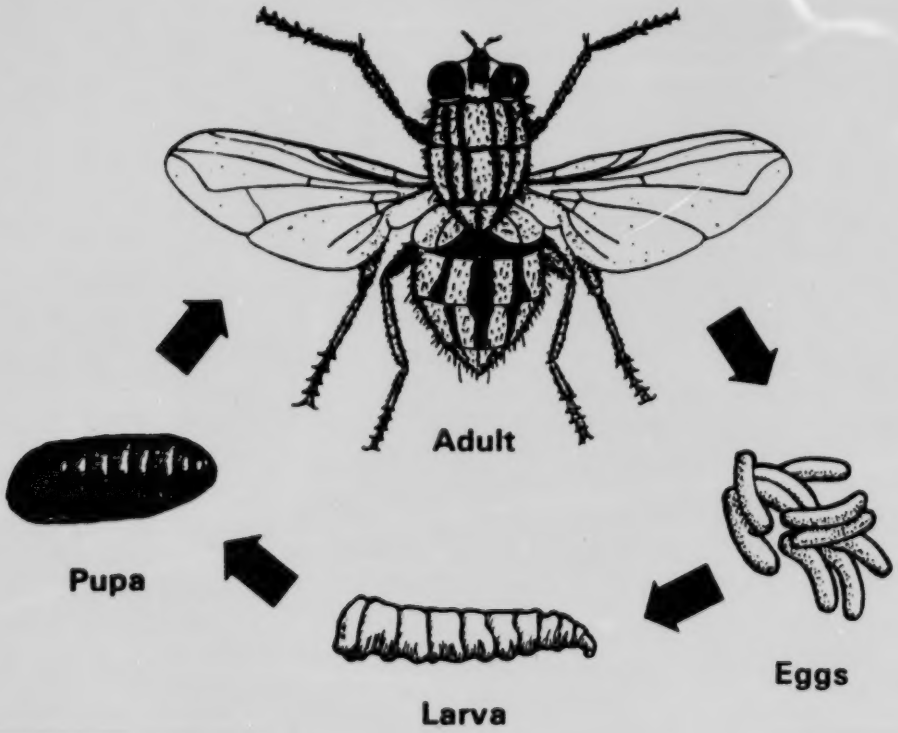


Fig. 18. Life Cycle of the House Fly

The mated female seeks a suitable site in which to lay her eggs. Of these related species, the house fly is the most prolific averaging well over 1000 eggs during her 1 to 2 month adult life. The other members of this group lay several hundred eggs during this period. Suitable larval habitat normally contains a large amount of decaying organic matter and may include manure and manure mixed with straw or hay, garbage, animal carcasses, and a variety of decaying plant material. Depending upon the species and the environmental conditions, these eggs hatch in less than 1 day to 5 days. The larvae undergo several molts and under the best conditions may pupate in 4-7 days in the house fly and face fly and in a little over a week in the other species. The length of the pupal stage follows a similar time schedule. Thus, under optimum conditions, the house fly and face fly may grow from egg to adult in about one week while for the stable fly, false stable fly, and lesser house fly, the time from egg to adult may be 2-3 weeks. During the warm summer months, 10-12 generations may be produced. Adults live about 1 month when the weather is hot and perhaps several months in cooler weather. These flies overwinter as adults in a variety of protected areas. Often, these areas include basements, walls, and attics of homes.

Flesh Flies - Flesh flies are gray, robust flies which are generally larger than the house fly. The thorax of the flesh fly has three dark longitudinal stripes rather than four as in the house fly. The abdomen has a checkered appearance and the

Fig. 19. Flesh Fly

tip of the abdomen in males is often reddish in color. Though larger, the larvae and pupae are similar to those of house flies.

The female lays a batch of 30-60 eggs or larvae in decaying plant material, animal carcasses, or excrement. If eggs are laid, they hatch almost immediately. The maggots undergo a series of molts, pupate, and emerge as adults in about 2-3 weeks.

Blow Flies - Blow flies or bottle flies are the same size or slightly larger than house flies. Blow flies are easily recognized by their shiny, metallic green, copper, blue, or black color although some kinds are dull and non-metallic. Larvae and pupae are similar in shape to those of the house fly but are larger.

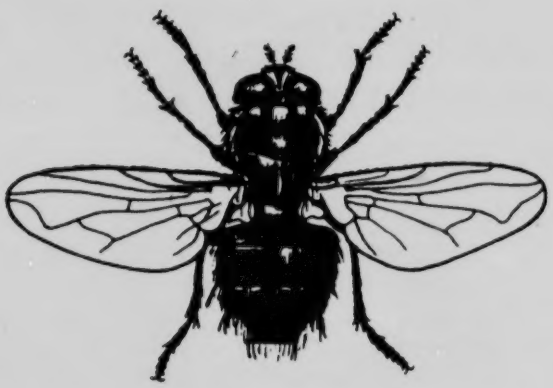


Fig. 20. Blue Bottle Fly

Fig. 21. Green Bottle Fly

Except for the green blow fly which lays about 2000-3000 eggs, the female blow flies produce an average of 500-700 eggs. The eggs are most often laid in meat and animal carcasses causing them to "blow" or swell with larvae. Eggs are also deposited in decaying vegetable matter. Under optimum conditions, eggs hatch in 4-6 days and develop to adults in 2-3 weeks. Adults

live an average of 5 weeks.

Fig. 22. Cluster Fly

Another pest in this group is the cluster fly. This fly is somewhat larger than the house fly and may be recognized by the numerous yellow or bronze colored hairs on the thorax and iridescent "checkerboard" patterned abdomen.

This fly is unique in that its biology and habits differ from the other members of this family. After mating, the female deposits eggs in the soil. The maggots are parasites of earthworms. They feed within the earthworm for 2 or 3 weeks before returning to the soil to pupate. The adults emerge in about two weeks and make their way to the soil surface. In New Jersey, there are 4 generations per year. Unlike many other members of this group, cluster flies are attracted to flowers and trees and rarely contact garbage, excrement, or other filth.

During the fall, cluster flies enter buildings to hibernate and may congregate in large numbers or "clusters" in attics, closets, or other protected areas. On warm winter days, when an infrequently used building is heated or with the approach of spring, they may become active. Their presence and loud buzzing may become a nuisance to many people but since cluster flies do not visit filth and are not attracted to man's food, they are of little public health importance.

Habits and Habitats:

As maggots, the house fly and its relatives are scavengers and are located in relatively small, confined, moist habitats which contain a large amount of organic matter. Examples of these habitats include decaying plant material, manure, garbage, and animal carcasses. As adults, these flies remain near the larval habitat to feed and breed but are strong fliers and have the ability to, and when necessary, travel several miles from these areas.

These flies, and especially the house fly, are attracted to man and domestic animals and readily enter homes, restaurants, food processing plants, and stables, barns, and other livestock areas in search of food and breeding sites.

Public Health and Economic Importance:

This behavior of freely moving from excrement, garbage, and filth to man, his dwellings, and food may help explain why these flies play an important role in the transmission of a number of diseases. The disease pathogens are picked up on their feet and mouthparts and spread when the flies then enter human dwellings and contact man, his food, and utensils, possibly contaminating them with a number of disease organisms. When contamination occurs, man completes the cycle by contacting these materials, contracting the disease and passing excrement which contains numerous disease organisms for other flies to contact this material and continue the cycle. In New Jersey, dysentary, typhoid, and a number of intestinal diseases could be transmitted in this way.

Another health related problem involving domestic flies is myiasis. Myiasis is the infestation of the tissues and organs of man and animals by fly maggots. A number of domestic flies lay eggs or deposit larvae in meat,

cheese, fruit, and other foods. If these foods containing maggots are eaten by man and survive the digestive juices of the stomach, they may live in the intestines causing nausea and diarrhea. In situations where privies are still used or soiled diapers remain on infants for long periods of time, maggots may enter the intestines via the anus. Other domestic flies can lay eggs or deposit maggots on open sores or wounds where they feed. In areas where the standard of living is high, the incidence of myiasis is low. Suspected cases of myiasis should be referred to a physician.

People tend not to patronize restaurants, hotels, and other establishments that support large populations of these flies. Although they don't take blood (with the exception of the stable fly), large numbers of these flies cause annoyance and many have the ability to transmit diseases.

Horse Flies and Deer Flies

Description and Biology:

Horse flies are large, heavy-bodied flies which may reach up to 1 inch in length. Deer or strawberry flies are generally smaller ($\frac{1}{4}$ to $\frac{1}{2}$ inch long) and their wings are often patterned with dark areas. Both groups belong to the family Tabanidae. Tabanids may be tan to black in color, often with distinct markings. The eyes are brightly colored or iridescent in many species.

Fig. 23. Horse Fly

Fig. 24. Deer Fly

Mating takes place soon after emergence. Once mated, the female deposits an egg mass on plants, rocks, sticks, or other similar objects usually over water or other favorable larval habitat. Egg masses are deposited throughout the life cycle of the female. Upon hatching, the larvae burrow into mud or moist earth and begin feeding. Depending upon the species and climatic region, there are usually 1 or 2 generations per year.

Fig. 25.
Life cycle of a tabanid fly:
Eggs, larva, pupa, and adult.

Habits and Habitats:

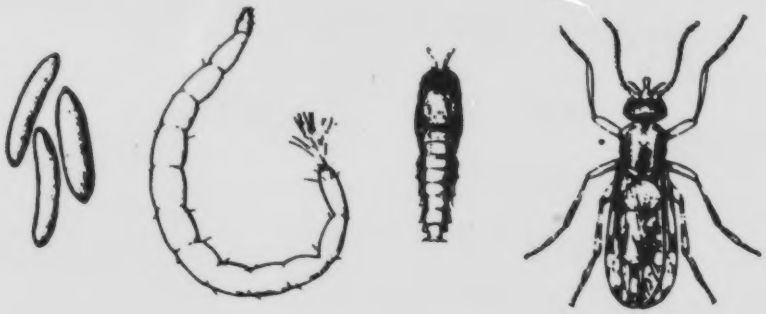
The larvae of most species are aquatic or semi-aquatic and are thus often associated with moist situations such as marshes, swamps, and shorelines of lakes and ponds. The larvae of deer flies feed primarily on decaying organic matter while those of horse flies prey upon a wide variety of invertebrates including each other. The larvae may molt well over 10 times before pupating and emerging as adults.

Although strong fliers, the adults are usually found around the larval habitat. They may move considerable distances to find a blood meal. Both sexes feed on plant nectar and pollen to obtain energy. Only the female feeds on blood in order to develop eggs.

Biting Midges

Description and Biology:

The biting midges are also known as no-see-ums, punkies, and biting gnats. Members of this group are slender and very small ranging in size from less than 1/32 to 3/16 inch long.



Egg Larva Pupa Adult

Fig. 26. Life Cycle of a Biting Midge

Habits and Habitats:

Like the tabanids, the larvae of this group are aquatic or semi-aquatic and are found in moist soil, decaying plant material near fresh or salt water shorelines, and treeholes. Adult females feed on blood.

Black Flies

Description and Biology:

Black flies or buffalo gnats are small (1/16 to 3/16 inch long), robust flies. The wormlike larvae are tan to black in color and may reach 1/2 inch in length before pupation. Pupae are found in small cases or "slippers" attached to rocks. Large, antler-like breathing structures on the front of the pupae aid in identifying this stage of the insect.

Fig. 27. Life Cycle of a Black Fly

Egg Larva Pupa Adult

The female will lay 200-500 eggs during her life. Larvae develop in 7-10 weeks.

Habits and Habitats:

The larvae and pupae are found only in rapidly running water, are completely aquatic, and live attached to rocks, submerged plants, or debris. Adults are good fliers and have been reported to travel up to 10 miles. Both sexes feed on plant nectar. The females take blood and cause great annoyance to man and animals. The irritation from large numbers of bites is very great.

Stable Fly

Description and Biology:

The stable fly is similar in appearance to the house fly in size and coloration but the mouthparts are quite different and adapted for piercing the skin and taking blood. Larvae and pupae are similar to those of the house fly.

Fig. 28. Stable Fly

The biology of this species is similar to that of the house fly and

other related forms.

Habits and Habitats:

Unlike its name implies, the stable fly occurs in fairly small numbers around stables. More often, this species breeds in vegetation strewn along the shoreline of lakes and bays. Accumulations of wet grass clippings or other vegetation are often used as breeding places. This species does not normally breed in excrement unless it is mixed with some type of vegetable matter and prefers a habitat more moist than that of the house fly. Both sexes feed on blood and large populations of stable flies may be very annoying.

Public Health and Economic Importance:

Like the house fly and its relatives, blood-sucking or biting flies are also of public health and economic concern but in somewhat different ways. Biting flies do not normally frequent excrement, garbage, and other filth and therefore not apt to transmit the bacterial diseases associated with these areas. In New Jersey, the chief public health problem arises from the annoyance resulting from their biting man and animals. Biting flies are attracted to man and domestic animals as sources of blood. During feeding, these flies may visit several animals. Should one of these hosts be infected, the transmission of the disease may occur. The horse and deer flies have been implicated as vectors of tularemia and anthrax in livestock in some areas of the United States. In other parts of the world, other closely related species have been responsible for several important diseases.

The nuisance created by these biting flies (including the stable fly) may have severe economic results. Large populations in recreational areas may drastically reduce tourism. In livestock production areas, the annoyance caused

by the presence and bites of these flies may result in lowered weight and milk production.

Control:

Control of the blood-sucking or biting flies is quite different because breeding sites range from dry areas to extensive wetlands and in the case of black flies, actual running water. In many cases, breeding sites are not known. Where they are known, the application of pesticides to control the larvae or adults would be ecologically unacceptable, quite costly, only temporary, and probably ineffective. For control in isolated areas, the collection and disposal of breeding materials such as decaying plant material may be effective. These flies have a variety of natural enemies which reduce populations somewhat but none of these predators or parasites has been effectively used in control programs. Various types of traps may help reduce local populations of certain species. Personal repellents may be quite effective against biting midges and black flies but offer little protection against horse and deer flies. Heavy clothing and light colored clothing will decrease biting. In dwellings, fine mesh screening will prevent entry by these pests.

By far the most important aspect in controlling the house fly and related species is proper sanitation. Sound sanitation includes adequate construction and maintenance of privies and manure pits; proper disposal of excrement, garbage, and animal carcasses; proper storage of waste materials; screening of man-made structures including homes, institutions, restaurants, and animal enclosures; and adequate drainage. Natural enemies of these flies are numerous but none have been widely used in integrated control programs. The necessity for chemical control procedures is a last resort and usually occurs

when sound sanitation has not been carried out. Properly labeled residual chemicals are most often applied to favored resting sites. Fly resistance to many pesticides is a major problem in chemical control procedures. If seen, flies that move into summer homes, basements, or attics to overwinter, may be easily collected and destroyed.

Moth Flies

Although they belong to the same family as the blood-sucking sand flies, moth flies do not take blood nor transmit disease. The economic importance of this pest involves the annoyance created by their presence. Large populations of moth flies common around sewage disposal plants are often a nuisance to workers and neighboring households. Sink or floor drains in poor working order are the main sources of breeding in homes.

Moth flies are small (1/16-1/6 of an inch), robust, dark colored flies. The presence of numerous hairs on the body and the pointed wings of this insect give it a characteristically "fuzzy" or "wooly" appearance. The worm-like larvae are grayish in color and reach 3/8 of an inch at maturity.

The female deposits eggs upon very moist organic matter associated with household sink drains and traps and floor drains or in the sludge of septic tanks, cesspools, or sewage disposal areas. These eggs hatch from within 1 to 4 days. Larvae feed upon the organic matter and depending on the conditions, may mature in 4-15 days. Pupation takes place on or in the moist organic material where the organism remains for 1-6 days before emerging as an adult. Although the average life cycle is completed in 2-3 weeks, under optimal conditions, this may be reduced to 1 week.

LICE

General:

Sucking lice are external parasites of many animals and any one kind occurs on only one species of animal. Those lice which feed upon man are the body, head, and crab louse and none of these live on any other animal. Lice (particularly body lice) transmit several diseases, especially during wartime, during natural disasters, or at times when people live in overcrowded and unsanitary conditions. The two most important diseases involving lice are louse-borne typhus and louse-borne relapsing fever but these diseases have not been reported in New Jersey for many years. More important is pediculosis or irritation resulting from the feeding of lice. In heavy infestations, the irritation may lead to scratching resulting in secondary infection and in hardened, scarred, and darkened skin.

Body Louse

Description and Biology:

The body louse is about 1/8 of an inch long with the female being slightly larger. This insect is grayish-white in color and flattened from top to bottom.

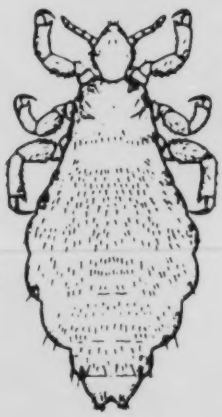


Fig. 29. Body Louse

Lice feed many times during their life. Mating occurs often throughout adult life. Once mated, the female lays eggs or "nits" within 48 hours. The females produce about 4 to 6 eggs per day and live about 30 days. Each female louse is capable of laying about 150 eggs. These eggs are individually glued to fibers of clothing. The eggs

will hatch in 8-10 days but this incubation period may be extended if the clothing is occasionally removed.

The body louse goes through 3 nymphal instars, averaging about 8 to 10 days to complete. At each molt, the nymphs resemble each other but become increasingly larger in size. The time of development may increase or decrease depending upon how long the clothes remain in contact with the host's body. The adults closely resemble the nymphs but are sexually mature and larger in size.

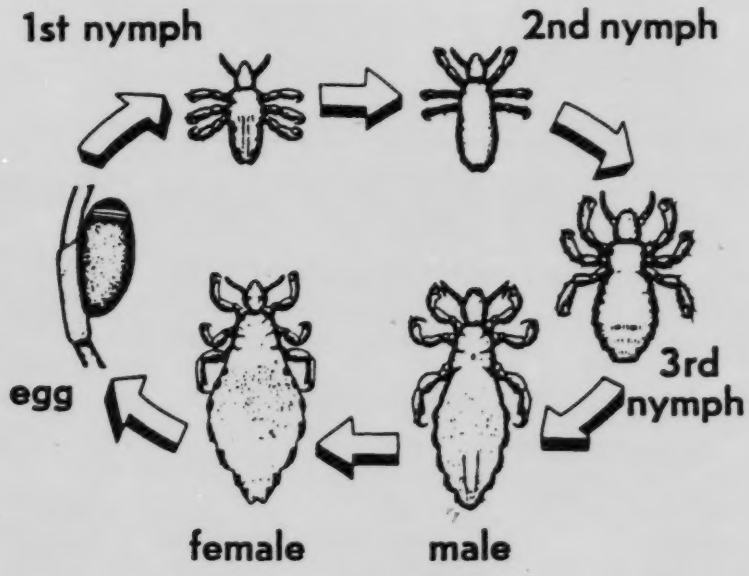


Fig. 30. Life Cycle of the Head Louse

Habits and Habitats:

The body louse (as well as the head and crab louse) is a sucking louse and immatures, males, and females feed often and exclusively on human blood. The mouthparts are fitted for piercing the skin and taking blood. When not feeding, the body louse normally remains in the host's clothing, especially

around the seams. Louse populations may spread when an uninfested person contacts a lousy person, infested garments, or infested furniture or bedding.

Head Louse

Description and Biology:

The head louse is very similar in appearance to the body louse but is somewhat smaller and its grayish-white body may be somewhat darker around the edges. Usually, these differences are not obvious and identification can best be made by locating the area of infestation. Head lice will infest the head area only while body lice will usually not occur on the head. The very small,oval yellowish-white nits may be seen attached to the hairs of an infested person.

The head louse female will produce only about half as many eggs as the body louse during her 30 day adult life. These eggs hatch in 5-10 days and the 3 nymphal instars may be completed in 8-9 days.

Habits and Habitats:

Head lice are most often found around the hairs of the scalp, especially near the ears and back of the neck. Because of man's constant grooming, populations may not become very large.

Head lice spread from person to person by directly contacting a lousy person or contacting or using infested furniture, brushes or combs, or headwear.

Crab Louse

Description and Biology:

Crab lice are grayish-white and about half the size of body lice. The second and third pairs of legs are thicker and longer than the first pair and are shaped like crab claws, giving this species its common name. The abdomen

is short and the sides of each segment have a tuft of hair. Adult crab lice live for about a month, during which the female lays several dozen eggs. These eggs will hatch in about a week and pass the three nymphal instars in approximately 2 weeks. The crab louse cannot survive for more than a day or two without a host.

Fig. 31. Crab Louse

Habits and Habitats:

Although commonly found around the pubic and anal areas of the body, crab louse infestations have been found on chest hairs, armpits, eyebrows, and eyelashes. Crab lice do not move as much as head or body lice.

Crab lice are spread by close personal contact, usually through sexual intercourse. Crab lice may also be picked up through contacting infested toilets or bedding.

Control:

The control of lice is not difficult but it involves the application of a pesticide to an individual's body or clothing. As a result, only a qualified person such as a doctor or public health official should attempt chemical control. Infested clothing should be laundered in hot water or dry cleaned. Remove all nits on hair with a fine-toothed comb or brush.

TICKS

General:

Ticks are not insects but are more closely related to mites and spiders. Ticks may be further classified into hard ticks (ixodids) and soft ticks (argasids). Both types are oval and flat but differ by the position of the mouthparts. All adults and nymphs have 8 legs while the larvae or first growth stage have 6 legs. In New Jersey, only hard ticks commonly become a nuisance or health problem.

Biology:

After feeding once as an adult and mating on the host, the female hard tick leaves the host, moves to a protected place, and after a period of development, deposits one large batch of several hundred eggs. These eggs may number several thousand per female. Soft ticks, on the other hand take several smaller blood meals and lay eggs after each feeding. Depending on the local conditions, these eggs will hatch in several weeks to several months.

After hatching, the tiny, six-legged larval or "seed" ticks seek a host. Ticks can withstand long periods of starvation but those that fail to locate a host die. When a host is found the "seed" tick takes a blood meal, drops to the ground, and molts to an eight-legged nymph. Likewise, this nymph must locate a host, feed, drop to the ground to molt, and finally emerges as an adult.

As adults, the sexes are readily distinguished. The females possess a small scutum (a hardened shield behind the "head") while the scutum of the male covers most of the body. Both sexes take blood but the male takes only a small amount. The smaller scutum of the female allows her body to become greatly distended with blood. Adult, unfed ticks are between 1/8 to 1/4 of an inch long, but after engorging with blood, the female may be 1/2 inch in length. After

feeding for several days and mating, most male ticks die. Shortly after laying her eggs the female also dies.

Under normal conditions, the life cycle of many hard ticks may take 1 to 2 years to complete. Much of this time is spent on the ground or on vegetation awaiting hosts. Most hard ticks are 3-host ticks, that is, they must locate and feed upon a host three different times to complete their development.

Brown Dog Tick

This species is uniformly reddish-brown in color and feeds almost exclusively on dogs. Man is rarely attacked. In New Jersey, the brown dog tick is not known to transmit disease. This semi-tropical tick is an indoor pest in New Jersey and all stages may be seen crawling on walls, carpeting, and furniture in infested dwellings. After hatching, the larvae await the presence of the dog. Although these ticks may attach to and feed on any part of the dog, the ears and neck area are preferred.

An infestation of these ticks in the home may begin in several ways. The dog usually becomes infested from a home, boarding kennel, or animal hospital where an infestation exists. Dogs seldom get brown dog ticks from contacting infested dogs and even more rarely out of doors. Once feeding is completed after each stage, the tick will drop off the infested dog and molt before attacking the same or another dog in the next stage.

Brown dog tick infestations in the home may be difficult to control. Approved residual chemical treatments applied to floors, baseboards, and cracks and crevices may be effective. The dog should also be treated at this time but this is best accomplished by a veterinarian. The application of pesticides outside the infested home is not recommended since this is an indoor pest.

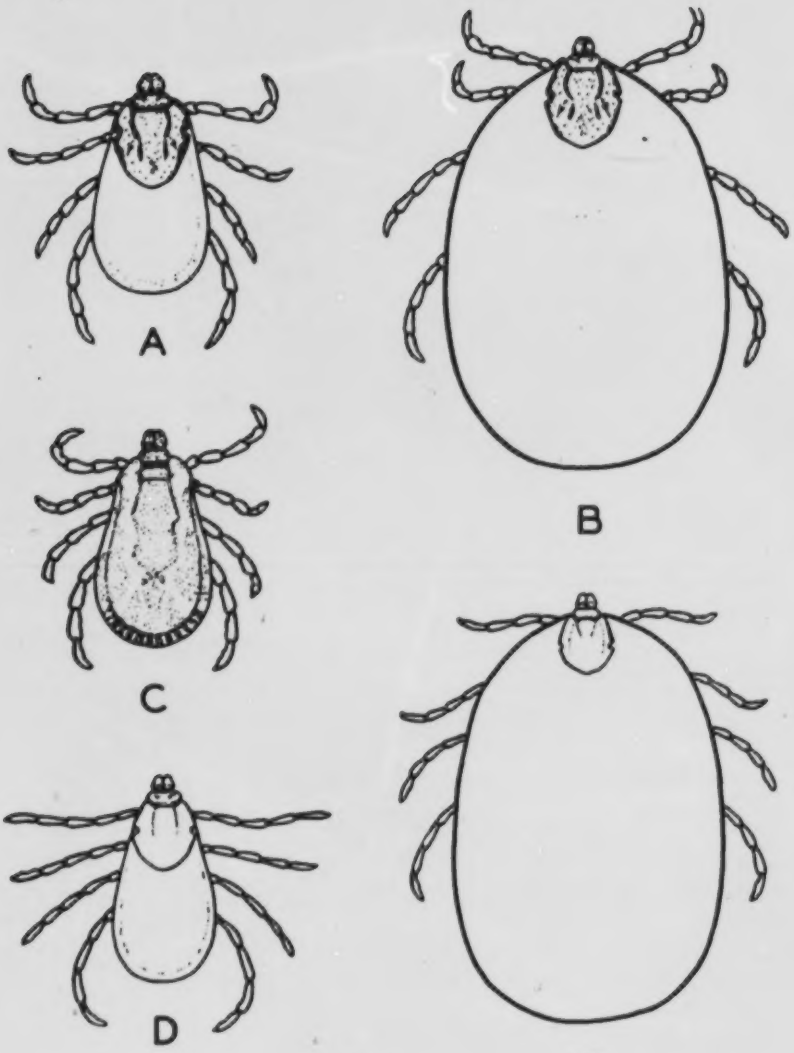


Fig. 32.

American Dog Tick—A. Unengorged adult female; B. Engorged adult female; C. Adult male.
Brown Dog Tick—D. Unengorged adult female; E. Engorged adult female.
(All enlarged about 7X)

American Dog Tick:

Although dog is the primary host, this species will readily feed on a variety of large mammals including man. This tick is dark brown in color

with light-colored, "mottled" markings on the scutum. Larvae and nymphs are light in color with reddish markings and usually attack small rodents while adult ticks are darker and attack larger mammals.

Unfed adults are about 1/4 inch in length. Unlike the brown dog tick, the male American dog tick will remain on the host and feed and mate for a longer period. The female feeds, mates, drops to the ground, and deposits her eggs. These ticks tend to congregate along animal runways, paths, and roads. Chemical treatments should be concentrated there. Keeping lawns and pathways through fields cut short may help reduce tick populations. The adults of the American dog tick readily attack man. Avoidance of tick infested areas, tucking trousers in socks and examining oneself after possible exposure to ticks are simple ways to reduce tick bites.

In New Jersey, the American dog tick is the means for the transmission of Rocky Mountain spotted fever. Outbreaks of this disease however, have not been numerous. If feeding ticks are removed too hastily and the mouthparts are left in the skin of the host, secondary infection may result. Tick paralysis is another health related problem but one which is uncommon. If feeding ticks remain attached to man for long periods of time, certain substances in the tick's saliva may affect the nervous system and cause paralysis. Recovery is generally rapid after the tick is removed.

FLEAS

Description and Biology:

Fleas are small (1/16 to 1/8 inch in length), brownish to black insects which are characteristically flattened laterally (from side to side). Adult fleas are wingless and are adapted for jumping relatively long distances. Although

many species of fleas feed primarily on one type of animal, the common cat flea and dog flea will readily take blood from a variety of animals including man. Flea infestations in the home will most likely involve the cat flea and less often the dog flea.

Fleas exhibit complete metamorphosis, that is, they develop from egg to larva to pupa and finally to adults. Except when actively feeding, adult fleas often live or hide in places such as pet beds, sofas, and carpeting, and other areas where cats and dogs frequent. After feeding and mating, the female will deposit her eggs, usually on the host. These eggs normally fall off the host into pet beds or other similar areas and hatch within two weeks. The common cat and dog fleas breed throughout the year. Flea larvae are tiny, light-colored, wormlike animals without legs. They feed primarily on various debris and organic material including the droppings of the adults which contain digested blood. Depending upon the kind of flea, the amount of food, and other environmental conditions, the larvae will pupate in one week to several months. The pupa is contained within a loose silken cocoon which is often covered with bits of debris. Under average conditions, the life cycle of the flea normally requires between 30 and 75 days but may take much longer.

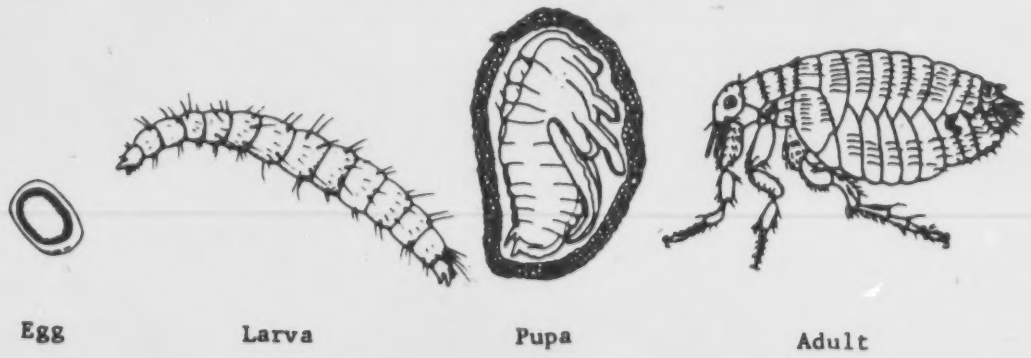


Fig. 33. Life Cycle of the Flea

Habits and Habitats:

Both males and females feed exclusively on blood. When the normal host is available, fleas may feed several times a day but are capable of surviving extended periods of starvation. In household situations, the cat or dog is normally the host. If the pet is temporarily or permanently removed, the starved fleas will readily seek other sources of blood and more often than not, man is the alternate host. In severe infestations, fleas will attack humans even though the normal host is present.

All control procedures should include a thorough "clean-up" to remove and destroy immature stages. Pet bedding should be cleaned or destroyed. Areas normally frequented by the pet such as floors, furniture, and rugs should be vacuumed and the vacuumed material should be discarded immediately. These areas may then be treated with a labeled insecticide. Pets may be dusted or otherwise treated with an approved (labeled) insecticide but this treatment should be left to the owner or veterinarian.

Fleas are involved in the transmission of diseases such as plague and murine typhus. Some fleas are also the intermediate host of tapeworms. New Jersey has no disease problems involving fleas. Rather, the major importance of fleas is primarily a nuisance problem. Persistant attacks by fleas may cause itching and irritation, often with secondary infection resulting.

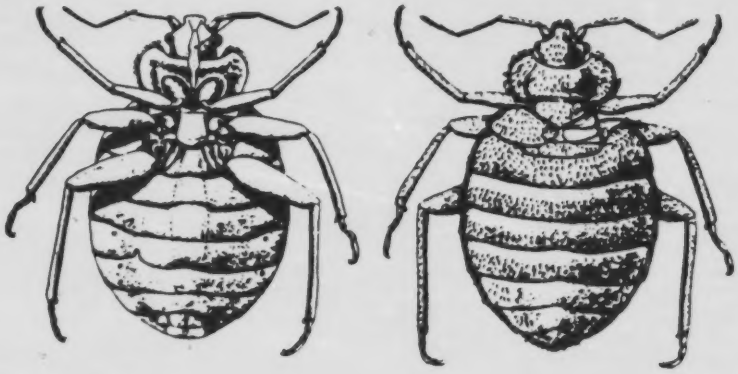
BEDBUGS

Description and Biology:

Bedbugs are wingless, reddish-brown in color, and as adults, are about $\frac{1}{4}$ of an inch in length. Bedbugs appear oval and flattened from top to bottom. This insect pest exhibits gradual metamorphosis. The nymphs are usually lighter in color but otherwise resemble adults.

Bedbugs maintain a close relationship with man feeding on blood at night and hiding in cracks and crevices associated with sleeping areas during the day. The female may lay 200-500 eggs during her life time, usually in batches of 10-50 eggs. These eggs are normally laid in cracks and crevices and behind loose wallpaper. Nymphs require between 1-4 months to develop depending on the environmental conditions. They are capable of long periods of starvation between molts; however, they must take blood at least 5 times before becoming adults. In addition, female bedbugs may feed a number of times prior to egg deposition.

Fig. 34. Bedbug



Ventral View Dorsal View

Habits and Habitats:

Bedbugs normally feed at night and are seldom seen during the day. Signs of bedbug infestations may include blood-stained sheets and bedding and dark colored excrement spots on areas where they normally hide during the day. Heavily infested areas have a characteristic "musty" odor, similar to that of large cockroach infestations. Bedbug infestations are spread by contact with infested persons, or use of infested sleeping quarters, public conveyances and meeting places and by movement of infested household goods.

Control is best achieved through sound sanitation practices and by crack and crevice treatment with approved residual insecticides. In hospitals or similar situations, infested bedsteads, matresses, and other furniture should be removed and treated where patients are not exposed.

Bedbugs repeatedly feed on man throughout their life causing intense irritation and localized swelling, but they have never been shown to transmit disease. Bedbug bites appear as small, whitish, hardened areas surrounded by a larger inflamed area. Constant scratching of these bites may result in secondary infection. Infested persons should consult a physician for treatment to relieve irritation.

MITES

General:

Mites are not insects, but are closely related to ticks. Most mites are of little importance to man but a few species are of public health and economic concern. From a disease standpoint in this country, only rickettsialpox has been shown to be spread by mites. Secondly, some sensitized people show allergic reactions (such as asthma) to whole or fragmented mites, their excretions, or their secretions. Perhaps of more importance is dermatosis or disease of the skin caused by mites. This condition occurs when mites crawl over or feed upon man. This skin irritation may be mild or severe with scratching and secondary infection often resulting. The severity depends on the species of mite, the size of the infestation, and the individual's sensitivity to the mite.

Other mites, though of no public health importance, may enter buildings

in large numbers and thus become a nuisance problem.

Description and Biology

Mites are quite small and many are microscopic. Classification of these animals is very difficult and any attempts to do so will be very limited.

Like ticks, mites have one body region. Besides being much smaller, the bodies of most mites are soft and not hardened or leathery like ticks. Their biology is also similar to ticks. The eggs hatch into 6-legged larvae. In some species, this stage does not feed while in others, feeding is necessary before the larval mites molt into 8-legged nymphs. Depending on the species, the mites undergo 1 to 3 nymphal instars before becoming 8-legged adults. Development may be completed in 1-8 weeks or more.

Habits and Habitats:

The behavior and habitats of mites vary greatly with the species. Some mites live in or on vegetable matter, food, or living vegetation and only become a problem to man if these materials are contacted. Other mites live on wild or domestic animals but man may become a secondary host when contact with these animals occurs. Finally, several mites such as the itch mite and follicle mite only attack man (host specific) and will not feed on other animals. Often only one stage of the mite is of medical importance.

Itch Mite

The itch mite is a true parasite of man which causes scabies. The female lays eggs in the host's skin. These eggs hatch and the larvae burrow in the skin where they develop to adults. Symptoms include itching, redness, and in sensitized persons, a rash may develop. Severe scratching may lead

to secondary infection. Itch mites are spread through close personal contact with infested people. Diagnosis and control should only be done by a physician or similarly qualified person. Closely related species are parasites on some domestic animals and these may occasionally attack man.

Fig. 35. Itch Mite

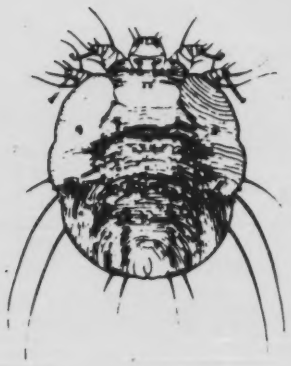


Fig. 36. Follicle Mite

Follicle Mites

These mites are host specific to man and are reported to be quite common. They occur in the hair follicles and as a result, may be important in certain skin conditions. Other related mites cause mange in certain domestic animals. Again, a physician should be consulted for positive diagnosis and control.

Chigger Mite

This mite normally feeds on wild mammals, reptiles, and birds but will feed on man. Chigger mites are parasitic only as larvae; the nymphs and adults prey on small insects and their eggs. The chigger mite attaches to the host and periodically injects saliva into the skin which causes the host's tissue

to liquify. The mite then feeds upon this material for about a day and drops off to molt. The feeding area, which usually occurs near belt lines, shoe and sock tops, or other areas of close fitting clothing, is a source of irritation. Severe scratching and secondary infection often follow feeding. Control may be achieved by keeping ground cover low or using a pesticide labeled for this use. Repellents offer personal protection.

Fig. 37. Chigger Mite

House Dust Mite

This mite is a common pest in many homes but is seldom recognized as being present. The house dust mite may occur in a variety of places such as on bedding, floors, and furniture, particularly in the bedroom. The mites (or parts of the mites), excretions, or secretions may cause allergic reactions, especially of the respiratory system. Removal by repeated vacuuming of infested areas and the laundering of bedding and clothing is usually effective in eliminating this pest.

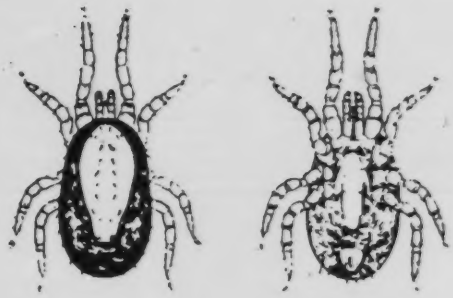
Northern Fowl Mite

This species is a general parasite of birds and is similar in appearance to the chicken mite. This mite usually remains on the host but like the chicken mite, can withstand fairly long periods of starvation. Attacks on man by this species are not as common as those by the chicken mite but cause similar effects.

Chicken Mite

The chicken mite attacks other birds beside chickens including pigeons, canaries, and wild song birds. Feeding normally occurs at night and after feeding the mite leaves the host and hides in cracks and crevices. Infestation of man is accidental and mostly rural but may occur in cities. Attack by these mites results in mild dermatosis.

Fig. 38. Chicken Mite



Dorsal View Ventral View

Tropical Rat Mite

Fig. 39. Tropical Rat Mite

This species attacks rats, a number of other mammals, and sometimes man. Their bites cause intense irritation which leads to scratching and often to secondary infection. The tropical rat mite is commonly a problem in warehouses, grocery stores, and private dwellings where rat infestations occur. This species leaves the host after feeding. Control may be achieved by eliminating rat populations but removal of the primary host may at first result in more severe attacks on man.

House Mouse Mite

This species is parasitic on mice and has been shown to transmit rickettsialpox when it feeds on man.

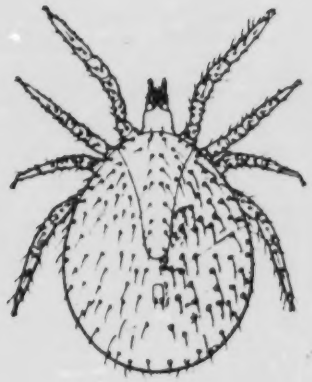


Fig. 40. House Mouse Mite

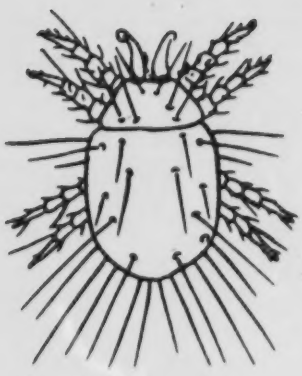


Fig. 41. Grain Mite

Grain Mites

So-called grain mites live in a variety of stored products. During adverse conditions, these pests are capable of long periods of survival without food and as a result, control may be difficult. They do not take blood. Their presence may result in a mild irritation sometimes known as vanillism or grocer's itch.

Mushroom Mite

This mite is common around mushroom beds, cereal grains, cheese, and other stored products. The mushroom mite is not a blood feeder but a mild irritation may occur if contacted. As with the grain mite, once the source of infestation is eliminated, the irritation usually subsides.

Straw Itch Mite

This mite lives on insect larvae associated with straw or other grain products and people working with these materials may become affected. The eggs hatch within the female's body where they are raised and eventually born as sexually mature adults. Feeding results in itching or the development of a rash. In highly sensitized persons, nausea, headache, vomiting, fever, and joint pains may occur. Control is best achieved by removing the source of infestation.

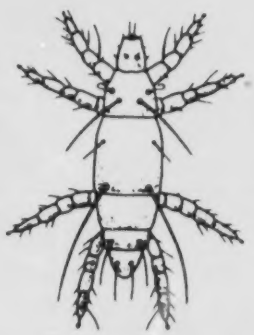


Fig. 42. Straw Itch Mite

Clover Mites

Fig. 43. Clover Mite

Clover mites do not feed upon man but are a common pest and should be distinguished from parasitic mites. Clover mites feed upon the juices of a variety of plants and are often associated with new lawns or plantings. Although they do no direct damage when entering residences, draperies, walls, and furniture may become stained if the mites are crushed.

Clover mites are reddish-brown in color and somewhat smaller than the head of a pin. The first pair of legs are quite long and extended in a forward direction. Immature clover mites are redder and barely visible.

Eggs are deposited singly or in clusters beneath the bark of trees or in

cracks and crevices associated with exteriors of buildings. Most eggs normally hatch in the spring and fall when the temperatures range between 45-65° F. During high temperatures, the eggs remain dormant. The immature mites molt three times with 2-6 days between molts and under favorable conditions, up to 5 generations may be produced per year. Clover mites may overwinter in all stages. During warm winter days, the mites may become active. If closely associated with buildings, the warm air of the interior may attract the mites indoors. Control is achieved by applying a labeled miticide to foundations, the perimeter of the residence, and lawns.

Spiders

General:

The very rare, fatal poisonings caused by a few species and an abundance of superstition surrounding them have given spiders a bad reputation. People object to seeing spiders in their homes and their webs are considered a nuisance. In general, spiders are beneficial because they feed on insects and other arthropods.

Some spiders are capable of biting man but rarely do so because of their retiring nature. Although most spiders have venom, it is usually too weak to be of much concern. The bite may be accompanied by slight soreness and itching or perhaps a burning or throbbing sensation. Of all the spiders native to New Jersey, only the black widow is considered of public health importance. Other "poisonous" spiders may occasionally be brought in with shipments of food and the like from other states or countries but rarely does a problem result.

Black Widow

Description and Biology:

Like all spiders, the black widow has 8 legs in all stages and two body regions (cephalothorax and abdomen). This spider is shiny black and has a characteristic yellow to red colored "hour glass" marking on the underside of the abdomen. With legs fully extended, the female may reach $1\frac{1}{2}$ to 2 inches in length; the body is about $\frac{1}{2}$ inch long. The male is somewhat smaller.

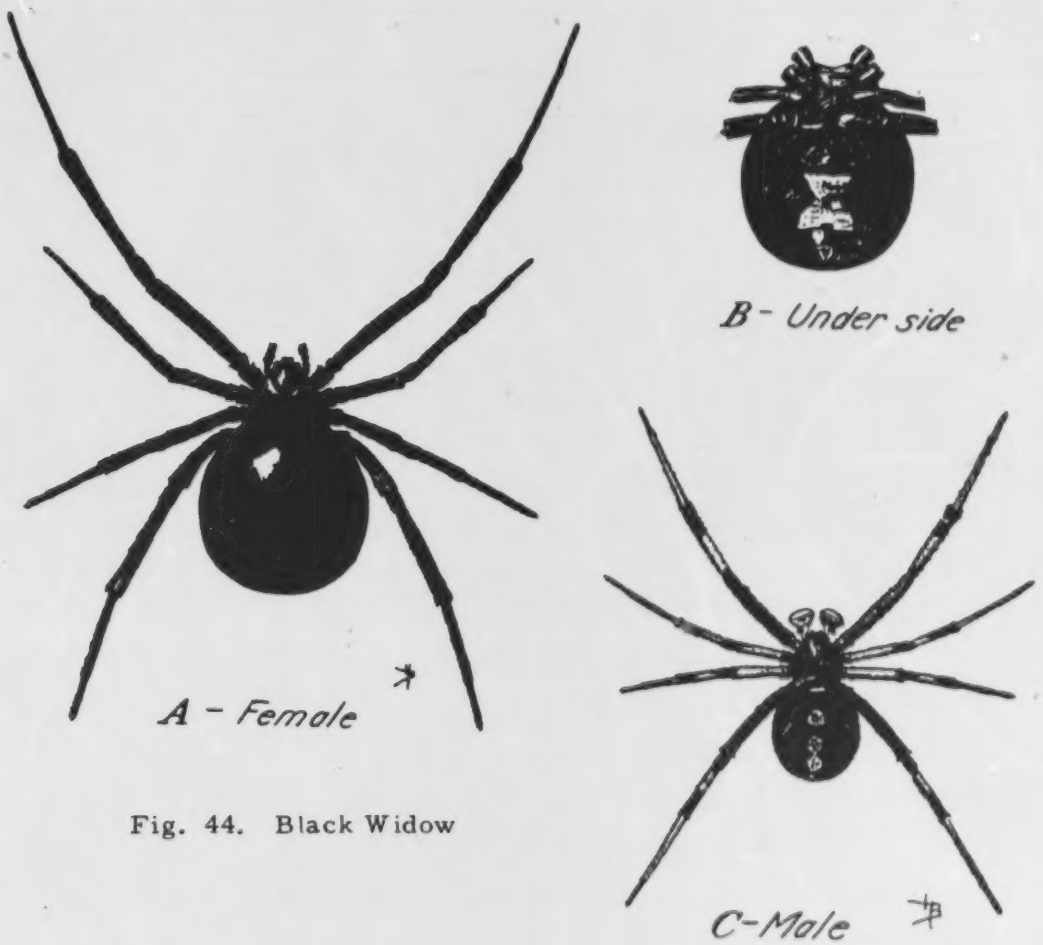


Fig. 44. Black Widow

Black widows normally overwinter as adults. After mating in the spring, the male soon dies or is sometimes killed and eaten by the female. The female constructs a tan colored silken sac in which she may lay 200-800 eggs. Several

such sacs may be produced during her 1-2 year adult life. The eggs hatch in a short period of time and the young spiders remain in the sac for several weeks. After emerging from this sac, the immature spiders disperse into new areas by spinning a silken thread which is carried by the wind. The young spiders molt several times and may take 3-11 months to mature.

Habits and Habitats:

Black widows occur indoors or outside and are commonly found under rocks or wood piles, under eaves or siding of buildings, in barns, out houses, and sheds, in culverts, and in basements.

Black widows construct irregularly shaped webs where they trap insects and other arthropods, their chief source of food.

This spider is not aggressive and will only bite man if disturbed or molested. At first, the bite of the black widow may result in a stinging sensation shortly followed by localized pain. Severe pains to the abdomen, chest, and limbs may occur and last for more than a day. Although the black widow bite results in great discomfort, deaths rarely occur. The severity of the symptoms depends on the amount of venom that was injected during the bite and the sensitivity of the person being bitten. The deaths that are occasionally reported occur in young, elderly, or ill persons. Consulting a doctor is always advisable after a bite to lessen complications.

Control may be achieved with a pesticide labeled for this use.

INVERTEBRATE PESTS: STORED PRODUCT, PANTRY, GRAIN, AND FABRIC

Flour Beetles

The red flour beetle and the confused flour beetle are two of the most common pest species of stored products including grain, flour, herbs, beans and peas, some drugs, cereal products, and a variety of other starchy foods. They are common in flour mills, grocery stores, warehouses, and households. The red flour beetle is more common in grain storage areas on farms.

Flour beetles are reddish-brown, elongate and about 1/8 of an inch long. The cream-colored larvae are quite small after hatching but reach 1/4 of an inch when mature. Larvae have 3 pairs of legs and a pair of "hooks" at the top of the posterior end of abdomen. Pupae are white to light brown in color.

Fig. 45. Confused Flour Beetle

Fig. 46. Red Flour Beetle

Although both are similar in appearance, each species has different developmental temperature and humidity preferences. Under favorable conditions, the female may live 2 years or more and deposit about 1000 eggs. These eggs are laid on or near the food source and hatch in 1-2 weeks. The larvae

require 1-4 months to mature. The pupal stage lasts 1-2 weeks. Adults are quite active and move quickly when disturbed. In heated areas, 3-4 generations may be produced per year.

Flour beetles are normally only able to breed in milled products such as flour or damaged grain. If infestations become severe, the products will be unfit for consumption and should be discarded. Vacuuming cracks and crevices of the storage areas will aid in control.

Saw Toothed Grain Beetle

Like the flour beetles, the saw toothed grain beetle attacks a variety of food products including flour, cake mixes, ground spices, and pet food pellets. This pest is unable to attack sound grain and seeds and its presence usually follows attacks of other stored grain pests.

The adults are small (1/10 of an inch) reddish-brown beetles which are characteristically flattened from top to bottom. This beetle has saw tooth-like projections on the sides of its thorax which may further aid in identification. The larvae are white with brown heads, have 3 pairs of legs, and are about 1/8 of an inch when mature.

Fig. 47. Saw Toothed Grain Beetle

The female saw toothed grain beetle deposits 50-300 eggs during her lifetime of about 1 year. The eggs are laid near or on the food source and hatch within several days to 2 weeks. Larvae mature in 2-10 weeks and pupate where they remain for 1-3 weeks. Under favorable conditions, the complete life cycle may be completed within 1 month. Under average conditions, 4-6

generations may be produced per year. Adults rarely fly. All stages cannot survive temperatures of 0°F or 125°F for a period of one day.

Indian-Meal Moth

Indian-meal moths are a common pest of stored food products in the home and in a variety of food handling establishments. This species infests a wide range of products including grain meal, dried fruits, nuts, breakfast foods and pet food pellets.

Indian-meal moths are about 3/8 of an inch long and have a wingspan of about 5/8 of an inch. They may be distinguished from other household pest moths by their characteristic wing coloration. The basal (nearest the body) portion of the forewing is grayish in color while the outer half or two-thirds of the wings and the body appear metallic bronze. The hind wings are grayish white. Larvae are usually white but often exhibit a light green or pinkish tinge and when fully grown may reach 1/2 inch in length. Infested products are likely to contain webbing and frass (excrement) of the larvae. Pupae are light brown and are found in silken cocoons.

Fig. 48. Indian-meal moth

Adult Indian-meal moths mate soon after emerging. The female usually lays well over 100 eggs during her adult life of about 2 weeks. The eggs hatch within 2 weeks. Larvae live and feed near or within a silken case and in heavy infestations, the entire infested products may be matted with this webbing. Some mature larvae move to the surface of the stored product, spin a cocoon and pupate while others commonly migrate away from the source of food before pupating. After a 2 week pupal period, the adults emerge. The adults are most active in

the evening and may occur some distance from the larval food source. Adults do not feed. Under favorable conditions, 6 generations per year may be produced.

Angoumois Grain Moth

At one time, this moth was a very destructive pest to stored grain and ear corn throughout the United States. Today, serious infestations rarely occur. It is seldom a pest in households.

The Angoumois grain moth is yellow to tan in color, is about 1/4 of an inch long, and has a wing span of about 1/2 inch. The light gray hind wing is heavily fringed with hairs. The larvae are about 1/5 of an inch long at maturity and are white with yellowish heads.

Fig. 49. Angoumois Grain Moth

Larvae hatch in 1-4 weeks and both the larvae and pupal stages occur within kernels of grain or corn. In most grain (especially wheat) only one larva occurs per kernel while 2 larvae are common in a kernel of corn. The larval period normally lasts 3-4 weeks but this pest may overwinter in this stage in unheated storage areas. Adults emerge after about 2 weeks in the pupal stage. Adult females lay several hundred eggs either singly or in small batches. In unheated storage areas, breeding is continuous but in the Northeast about 2 generations are completed per year.

Mediterranean Flour Moth

The Mediterranean flour moth is an important pest of flour in commercial mills but will also attack whole grain, corn, wheat, and bran as well as packaged foods. In the home, this pest may also infest flour and other pantry products such as bread, cake mixes, and cereals.

Adults range from 1/4 to 1/2 of an inch in length and are light gray in color. Two faint, zigzag bands of black scales mark the forewings. Larvae are white to pinkish-white and reach 3/5 of an inch at maturity. Unlike the beetles, larvae have prolegs. Pupae are found in silken cocoons.

Fig. 50. Mediterranean Flour Moth

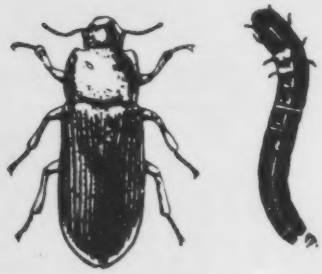
Eggs are deposited on flour and other food sources or in cracks and crevices and other secluded places nearby. Hatching occurs within 1 week. Soon after hatching, larvae spin silken threads. These threads eventually form a tube from which the larvae feed. As with the Indian-meal moth, masses of this webbing in heavily infested products is the chief source of economic loss. After feeding for about 6 weeks, the fully grown larvae spin cocoons and pupate where they remain for 1-2 weeks. Under favorable conditions, the life cycle may be completed in 9-10 weeks.

Mealworms

Several species of mealworms are pests throughout the United States. The dark mealworm occurs throughout the United States while the yellow mealworm is the more common pest in the Northeast. Mealworms are most commonly found in dark, moist areas where the grain has not been disturbed for some time or where it has begun to spoil. Mealworms are primarily pests of cereal and cereal products but are scavengers and will feed on other food products.

The adults of both species are black and flattened and range from 1/2 to 1 inch in length. The adult yellow mealworm is shiny black in appearance. Fully grown larvae are 1 to 1 1/2 inches long and resemble wireworms. Mealworm larvae are yellow to yellow-brown in color. Pupae are white and do not spin a cocoon. Separation of the 2 species is difficult in the larval stage.

Fig. 51. Mealworm



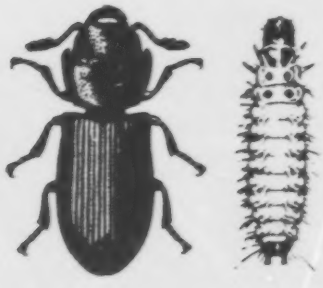
Adult Larva

Mated females lay between 200-1000 eggs in the larval food source. The eggs hatch in from 1-3 weeks and develop into mature larvae in 6 months to well over a year. Overwintering takes place in the larval stage. The pupal stage lasts from 1-3 weeks and the adults live only about 3 months.

Cadelle

On occasion, this beetle may become a serious pest of stored grain and seeds. This pest may also become a problem in flour mills, biscuit and cereal factories, and the home. The cadelle also damages some cloth and cartons of packaged goods. Larvae and adults also prey upon other insect larvae.

Fig. 52. Cadelle



Adult Larva

Adults are black and about 1/3 of an inch long. A constriction between the thorax and abdomen aids in the identification of this pest. The whitish larvae have black heads, black spots on the thoracic segments, and a pair of dark hooks at the tip of the abdomen. When fully grown, the larvae may reach 2/3 of an inch in length.

Eggs are deposited in groups of 10-60 and are usually laid in protected areas on or near the food. The adult female may lay well over 1000 eggs. The larvae hatch in 1-2 weeks and may take between 3-14 months to develop. Adults and full-grown larvae commonly bore into wood near the food source for hiding places or places to pupate. Adults live about 1 year.

Drug Store Beetle

The drug store beetle is a common pest which feeds on a wide variety of stored food products. It is a pest of homes as well as commercial establishments.

The adults are small (1/10 of an inch) and reddish-brown in color. The body of the adult is covered with short, light-colored hairs. Larvae are grub-like and reach about 3/16 of an inch when fully grown. They are whitish in color with brown heads and legs. Pupae are often found within a cell constructed of particles of the stored food products. Adults of the drug store beetle and cigarette beetle may be separated by differences in the antennae. The last three segments of the antennae of the drug store beetle are enlarged while those of the cigarette beetle are not.

Fig. 53. Drug Store Beetle

Larva Pupa Adult

The mated female deposits about 100 minute, whitish, oval eggs in crevices of stored food products. These eggs hatch in about a week. After

feeding for 30-50 days, the mature larvae pupate in silken cocoons. This pupal stage lasts about 10 days. Adults do not feed. Under normal conditions 3 generations are produced each year.

Cigarette Beetle

The cigarette beetle is another common pest of stored products but its diet is not as varied as the drug store beetle. Although the cigarette beetle prefers tobacco and tobacco products, no stored plant products are immune.

Fig. 54. Cigarette Beetle

Larva Pupa Adult

Cigarette beetles are light-brown, rounded in appearance, and are about 1/16 to 1/10 of an inch in length. The head and thorax are bent downwards giving this species a characteristic "hump-backed" appearance. The grub-like larvae are yellowish-white with a light brown head and very hairy. Fully grown larvae are about 1/16 of an inch in length.

The biology of the cigarette beetle is quite similar to that of the drug store beetle. The adult cigarette beetles as well as the larvae feed on stored products. The developmental period of the cigarette beetle is somewhat shorter than that of the drug store beetle.

Granary and Rice Weevils

The granary weevil and rice weevil remain important worldwide pests of stored whole grains but are much less of a problem in the United States today.

Since both species feed primarily on whole grains, they are most often pests in grain storage areas and only occasionally become a household problem. Both beetles have prominent snouts and are thus true weevils.

Granary Weevil

The granary weevil is about 1/16 of an inch long, cylindrical in shape, and uniform reddish-brown to black in color. The hind wings are poorly developed making flight impossible. The top of the thorax (pronotum) of the granary weevil is marked with large, oval pits. The larvae are white with a brownish head, legless, and hump-backed in appearance. The larvae are about 1/8 of an inch long when fully grown. The larvae and pupae are seldom seen.

The female chews a small hole in the kernel of grain and lays an egg. During her 8 month lifetime the female may deposit about 250 eggs. The larvae hatch in several days, feed within the kernel for about 3 weeks, and pupate. After about a week in the pupal stage, the adult cuts an exit hole and emerges. Under favorable conditions, a generation may be completed in 4-7 weeks with 4-5 generations per year. Adults are able to survive up to 3 weeks without food.

Rice Weevil

Adults of this species are about 1/8 of an inch and reddish-brown to almost black in color with two faint yellowish patches on the front and back of each forewing (elytron). The pronotum is marked with small round pits. Larvae and pupae are similar in appearance to those of the granary weevil.

The biologies of the rice weevil and granary weevil are similar. The female rice weevil is capable of depositing 300-900 eggs during her 4-5 month adult life. Two larvae may develop within a single kernel. Rice weevils are

capable of flight and have been shown to invade fields and infest standing grain.

Infestations of both species may be controlled by subjecting the products to cold or heat and by fumigation. The rice weevil is more susceptible to cold temperatures.

Other species of weevils may be found indoors and should not be confused with the granary or rice weevils. These weevils are occasional pests and are normally found outside feeding upon foundation plantings. They do no harm indoors and probably enter residences to overwinter or search for food. Adults have irregular or roughened body shapes and are usually covered with hairs or scales. The stored product-infesting weevils are smooth with a regular body shape.

Larder Beetle and Related Species

The larder beetle and to a lesser extent the hide and incinerator beetles were at one time, important pests of a wide variety of meat and animal products. However, with modern refrigeration methods in supermarkets and homes, these pests have become rare. As a group, these pests are referred to as dermestid beetles. These pests may be found in many areas of meat processing establishments. Food preparation areas may also become infested. Often, successful control programs against domestic rodents, squirrels, bats, and insects such as bees may result in dermestid beetle infestations. Pests which are killed and whose carcasses remain in wall voids, cracks and crevices, and basements or attics may serve as a food source and result in an infestation.

Adult beetles are dark brown in color, oval, and range from 3/16 to 1/3 of an inch in length, depending on the species. Larvae are densely covered with hairs and are more or less reddish-brown in color. Larvae reach up to

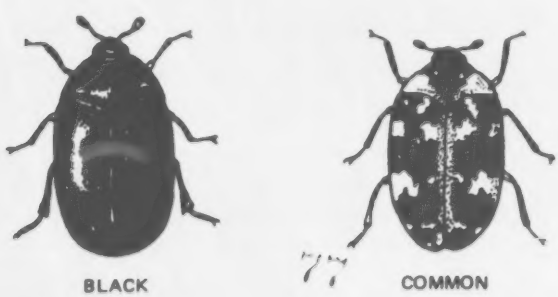
1/2 of an inch when fully grown and pupation takes place within the larval skin.

Eggs are deposited on or near a suitable larval food source. This food source is quite varied but feeding on some animal product is necessary for complete development. Many of the details on the length of development are not fully known. Development time is very much dependant on environmental conditions, quality of larval food, and species. On the average, development from egg to adult requires 50-60 days with the adults living several months.

Carpet Beetles

Carpet beetles belong to the same family as the larder beetles and related species. Carpet beetles are scavengers and attack and do serious damage to clothing, upholstering, curtains, and furniture stuffing, particularly those with a wool content. Other materials attacked include hair, feathers, fur, dried meat and milk, grains and flour, and a variety of other plant and animal products. They are often associated with other scavenger insects and rodent, bird, and bat harborages. With the increased use of synthetic fabrics, the importance of carpet beetles as fabric pests has declined. The most important pest in this group is the black carpet beetle. Other carpet beetles belonging to the genus Anthrenus have sufficiently different habits than the black carpet beetle and shall be discussed separately.

Fig. 55. Adult Carpet Beetles



FURNITURE VARIED

Black Carpet Beetle

The black carpet beetle is the most economically important of all the carpet beetles. This pest feeds on a variety of plant and animal products especially those which have been left alone or forgotten for some time.

Adults are small (1/8 of an inch), dull black beetles. The brownish larvae may reach 1/4 of an inch at maturity and are characteristically quite hairy. The larvae of this species has a tail of long black hairs originating from the tip of the abdomen. Pupae are soft and white.

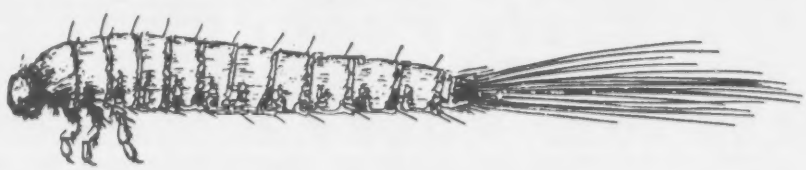


Fig. 56. Black Carpet Beetle Larva

Larvae of the black carpet beetle tend to burrow in the products they infest. In unheated situations, this pest overwinters in the larval stage. Larval development takes from less than 1 year to nearly 3 and is largely dependant upon environmental conditions and food. Pupation takes place within the larval skin. Adults live up to several months but as pollen feeders, they are not responsible

for any damage. Eggs are laid in dark situations on or near the larval food source. Only the adults are attracted to light.

Anthrenus Carpet Beetles

This group comprises the furniture carpet beetle, the varied carpet beetle, and the common carpet beetle.

The adults are slightly smaller than the black carpet beetle, and more or less round in shape. The furniture carpet beetle is nearly white with black spots on the elytra. These spots are outlined with yellow-orange scales. The varied carpet beetle is grayish in color. The common carpet beetle is grayish to black in color with patches of white scales. The inner margins of the fore-wings (elytra) are reddish in color which appear as a red band down the back. The underside of the beetle is yellow to pink in color. Larvae are similar but lack a long, black "tail" at the tip of the abdomen.

The habits of the adults of this group are similar to those of the black carpet beetle; all are fairly strong fliers and are attracted to light. Adults cause no direct damage and feed primarily on the nectar and pollen of flowers. Larvae of the Anthrenus carpet beetles do not burrow as do the black carpet beetle larvae, but tend to feed in groups near the surface of the infested material. Like the black carpet beetle, the larvae prefer to feed in dark secluded areas that have not been disturbed for some time. Larvae of the furniture carpet beetle may develop to adults in only 3 months under favorable conditions. The basic biology of the carpet beetles is quite similar.

Clothes Moths

Clothes moths comprise several species which are primarily pests of woolens, feathers, upholstered furniture, and virtually all dried animal products

such as hair and leather. Today, with the extensive use of synthetic fabrics for clothing and upholstering, the importance of clothes moths has declined. The main pests in this group are the larvae of the webbing clothes moth and the casebearing clothes moth. In the case of the webbing clothes moth, infestations are indicated by silken threads running over the surface of the infested material, holes in the infested goods, and the presence of larvae and adults. The casebearing clothes moth larvae similarly eat holes in infested goods but live and feed from within silken cases and do not spin webbing over the infested materials.

Clothes moths are uniformly yellow or buff-colored and have a wing span of about 1/2 of an inch. At rest, the wings are held roof-like over the body. The larvae are white and reach about 1/3 of an inch in length when mature. The larvae of the webbing clothes moth are free living while those of the casebearing clothes moth live with silken cases. These cylindrical cases are somewhat flattened, larger towards the middle, and composed of silk and particles of food material. This case is carried by the insect throughout the larval stage. Pupae are white and about 1/6 of an inch in length.

Females deposit between 100-150 minute white eggs singly on the larval food source. The eggs hatch in about 1 week. The length of the developmental period (egg through adult) is largely dependant on environmental conditions and may take from only 6 months to well over 3 years. When occurring on fabrics, the chances of survival and more rapid development are enhanced if the material is soiled with particles of food. Pupation lasts from 1-4 weeks and in the case of the casebearing clothes moth, pupation takes place within the silken case. Adults of both species do not feed. Those clothes moths seen flying are usually

males. Clothes moths are not attracted to light.

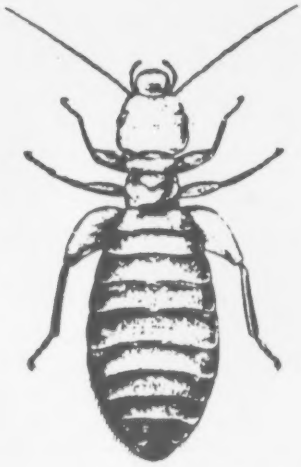
Booklice

Booklice or psocids do minor damage to papers and books in libraries or the home and may become pests in museums by damaging specimens. Occasionally, grains, cereals, and old, neglected packages of dried foods are attacked. In general, damage done by booklice is minimal and they are thus considered more of a nuisance pest. Booklice are most often associated with damp areas of old houses, granaries, and warehouses. Actually, most species of booklice feed upon microscopic molds that have grown on old papers and books which have been left undisturbed for some time in a moist environment.

Booklice are about 1/16 of an inch long; are pale yellow, tan, or gray in color; and more or less resemble aphids. Most species that become indoor pests are wingless. In winged species, the wings are held roof-like over the body and the immature stages are wingless. Booklice exhibit gradual metamorphosis.

Eggs are deposited singly or in batches and are often covered by debris or silken webbing. Immatures of most species undergo 6 nymphal molts before becoming adults. The length of time necessary to complete development is largely dependant upon the quantity and quality of food, temperature, and humidity. Since booklice require such damp environments,

Fig. 57. Booklouse



correcting conditions of high moisture is essential in controlling infestations of this pest.

Silverfish and Firebrats

Although they belong to a relatively primative order of insects, silverfish and firebrats are important household pests. These pests feed on a variety of starchy materials associated with paper, book bindings, wall paper, labels, and starched clothes.

Silverfish and firebrats are more or less gray or brownish wedge-shaped wingless insects often seen scurrying around at night in search of food. Their somewhat elongate, flattened bodies allow them to hide in cracks and crevices and other secluded places. Species which live outdoors are often associated with foundations, flowerbeds, or found under stones or other similar objects. These pests have long, multi-segmented antennae and 2 or 3 long bristle-like appendages arising from the tip of their abdomen. Silverfish and firebrats develop without metamorphosis. The immatures are almost identical in appearance to adults but smaller. Adults may reach 1/2 to 3/4 of an inch in length (excluding antennae and abdomenal appendages), depending on the species.

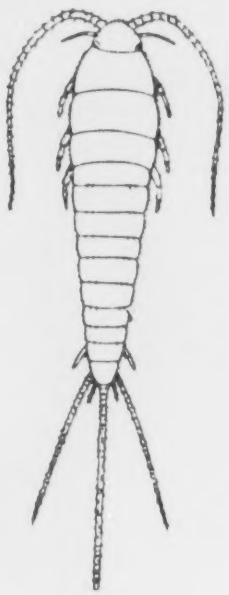


Fig. 58. Silverfish

Eggs are laid in small batches in secluded areas and usually hatch in one to many weeks. Firebrats generally have a high temperature requirement (90-105°F) and can withstand drier situations. Silverfish need fairly moist

conditions (70-85% relative humidity) but can live at lower temperatures. The four-lined silverfish, for example, can survive the winter in unheated buildings. The immatures are able to withstand extended periods of starvation. Development from egg to adult may take 3 months to over 2 years. In addition to recommended insecticides and poisoned baits, the correction of high moisture conditions is an important aspect of control.

INVERTEBRATE PESTS: OCCASIONAL

House and Field Crickets

Crickets are mainly outdoor pests of crops and gardens but on occasion enter dwellings. Damage to fabrics, food, furs, and some paper products may then result. The house cricket and field cricket are the species most apt to enter buildings. They are generally considered nuisance pests because of their presence and the chirping noise made by the adult males.

The house cricket is light, yellowish-brown in color, about 3/4 of an inch when fully grown, and has 3 dark-colored stripes on the head. Adult females have a characteristically long ovipositor while males have 2 bristle-like cerci on the tip of the abdomen. Field crickets are dark brown to black in color and are slightly larger than house crickets. Occasionally, lighter color specimens may be seen. Immature crickets (nymphs) are similar in appearance to adults but are wingless.

House crickets may be present in buildings throughout the year but rarely survive the winter outdoors. Females deposit up to 200 eggs which hatch within 3 months. Nymphs undergo 8-12 molts within 8 months before becoming adults. In the Northeast, usually one generation is produced per year. These crickets are nocturnal and hide in cracks, crevices, and other secluded areas

during the day.

In the Northeast, field crickets overwinter in the egg stage. The 150-400 eggs produced by the female are deposited singly in the soil. Eggs hatch in the spring and develop to adults in $2\frac{1}{2}$ - 4 months. In the Northeast, one generation is produced per year with the adults dying during the first severe freeze. Field crickets are more of an occasional pest indoors and are not able to survive within buildings during the winter.

Crickets may be found hiding in leaf litter and other debris around a foundation. Control is best achieved by removing this material and applying a 10 foot barrier of an insecticide labeled for that use along the foundation.

Centipedes

Centipedes are not insects but belong to the class Chilopoda. Although most species live outside, the house centipede is commonly found in residences. Centipedes are beneficial animals and as predators, primarily feed upon such household pests as flies, spiders, clothes moths, and cockroaches. However, when centipedes become too numerous, they are often considered a nuisance.

These gray to tan colored animals may be seen running quickly over walls and floors at night when disturbed. During the day they commonly hide in cracks and crevices or other secluded areas. Centipedes have elongate, flattened, and many-segmented bodies. Most body segments have a pair of long legs which are alternately colored with light and dark bands. The antennae and last pair of legs which are directed backwards

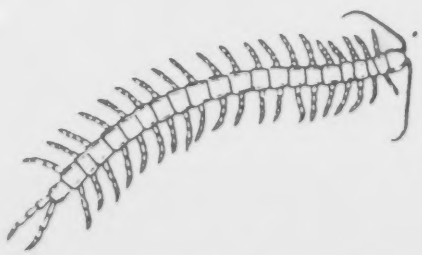


Fig. 59. Centipede

are very long and may reach twice the body length. Fully grown house centipedes approach 2 inches in length.

Eggs are laid singly in damp, secluded areas and are often covered with debris. The house centipede is normally found in basements, bathrooms, or other places where damp conditions prevail.

Millipedes

Millipedes are not insects but belong to the class Diplopoda. They breed and feed upon moist, decaying vegetable matter and are normally found outside. Occasionally, millipedes migrate and large numbers may enter residences. These invasions are probably triggered by some adverse condition in the millipede's environment. However, only a single millipede is usually encountered. Since they do not damage structures or furniture and do not bite or sting, they are only nuisance pests.

Millipedes are cylindrical, many-segmented, wormlike animals. Most millipedes are not larger than 1 inch and can be easily separated from centipedes in that they possess 2 pairs of legs on each abdomenal segment.

Fig. 60. Millipede

Each female is capable of laying about 300 eggs. These eggs are normally deposited in or on the soil in clusters of up to 100 eggs. Eggs hatch in about 3 weeks. Upon hatching, immatures resemble adults but are smaller, have fewer body segments, and initially have just 3 pairs of legs. Growth of millipedes is slow with one generation produced per year. Millipedes do not reproduce indoors.

Proper sanitation and the elimination of food and breeding sources near

structures will aid chemical control attempts. The removal of leaves or other decaying vegetation and landscaping materials such as peat moss from foundation walls will reduce the chances of millipede infestations. Compost piles should not be constructed adjacent to buildings.

Sowbugs and Pillbugs

Sowbugs and pillbugs are not insects but belong to the class Crustacea and are thus closely related to lobsters, crabs, and crayfish. These animals are primarily pests in greenhouses and similar areas where they do damage to roots and stems near the soil surface. Sowbugs and pillbugs may move indoors and do some damage to paper boxes and corrugated cartons improperly stored in damp areas.

The slow moving sowbugs and pillbugs are grayish-brown in color and may attain a length of 1/2 of an inch at maturity. They are oval, distinctly segmented, wingless animals with 7 pairs of legs. Sowbugs possess a pair of tail-like structures arising from the posterior part of the body. These appendages are absent in pillbugs. When disturbed, pillbugs tend to curl up in a characteristic tight ball.

Fertilized eggs are retained with the female's body for about 2 months before hatching. The hatched brood (25-75 individuals) remains within the female for some time. Sowbugs and pillbugs mature at about 1 year.

As with millipedes the removal of decaying organic matter from foundations will aid in preventing infestations with buildings.

Earwigs

Most species of earwigs are outdoor scavengers of organic debris such as decaying vegetable matter and dead insects, while others are predaceous.

Some species become pests in greenhouses and feed upon living plants. Earwigs normally live outdoors and although they sometimes become nuisance pests indoors, infestations are usually temporary.

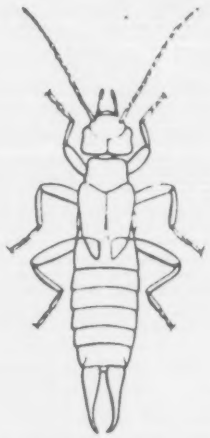


Fig. 61. Earwig

These insects are flattened, reddish-brown to black, and in some species, may reach $1\frac{1}{4}$ inches in length as adults. Earwigs resemble some beetles but are distinguished by the forceps-like structures at the end of the abdomen. Many species are wingless but others have shortened, leathery forewings which cover only part of the membranous hind wings. Several species can fly. Immatures resemble the adults but are smaller and wingless. Differences in color and in the shape and size of the forceps-like appendages may also be evident in the nymphs.

Earwigs deposit small clusters of eggs outdoors in subterranean chambers. The female actively protects the eggs and newly hatched nymphs. There is usually one generation per year. The winter is passed in the adult or egg stage. Earwigs are nocturnal and hide in secluded areas during the day.

Ground Beetles

Ground beetles refer to a large number of beetles which live and breed outdoors but may occasionally enter buildings and become nuisance pests. Many people confuse ground beetles with cockroaches. These insects are not structural pests nor do they infest household products.

Ground beetles come in a wide variety of shapes, colors and sizes (1/16 to 1 3/8 inches in length) although most species are shiny black and

about 1/2 of an inch long. The eggs, grub-like larvae, and pupae occur outdoors.

Eggs of ground beetles are laid in the soil. Both adults and larvae are predaceous on insects. The larvae hide under debris and are rarely seen. Depending on the species, one to several generations are produced per year. Adults are active at night and readily fly toward lights. Proper management of lighting will discourage them from entering buildings. The removal of debris around foundations will aid control attempts.

VERTEBRATE PESTS

DOMESTIC RATS AND MICE

Economic and Public Health Importance

The presence of a single mouse or even a rat may not be cause for alarm but when infestations are large, rats and mice become serious pests of man. Although these rodents eat large quantities of human and livestock food, their chief economic importance lies in the vast amount of food they contaminate with their urine, feces, hair, and other filth. While searching for food or nesting materials, rats and mice may destroy a variety of food packaging and containers, paper goods, cloth and clothing, and furniture. They may do structural damage to buildings by gnawing. People will tend to avoid establishments which show signs of rat or mouse infestations.

These domestic rodents support populations of potential disease transmitting organisms such as fleas and mites and thus aid in the spread of such diseases as plague, murine typhus, and rickettsialpox. Although these diseases are of great importance in many parts of the world, they are not a problem in New Jersey.

General:

The Norway rat and roof rat are the two rats of economic importance in the United States. Of the two, only the Norway rat is important in New Jersey with the roof rat occurring primarily in the Southern and West Coast States. Because of this distribution, only the Norway rat will be discussed. The house mouse is the other important domestic rodent in New Jersey.

Norway Rat

Description and Biology:

The Norway rat is also known as the brown, sewer, house, barn, or wharf rat. This species averages between 12-18 inches long (from head to tip of tail) and weighs about a pound when mature. The Norway rat ranges in color from reddish to grayish brown to black. The under portion of this rat is usually lighter, ranging from gray to yellow-white. Normally, adult Norway rats and house mice are easily separated by size. Confusion may arise over the identification of immature rats vs house mice. In general, the head and feet of the immature rat are relatively large compared to the rest of its body. The head and feet of the house mouse are

Fig. 62. Norway Rat

smaller and more in proportion to its body size.

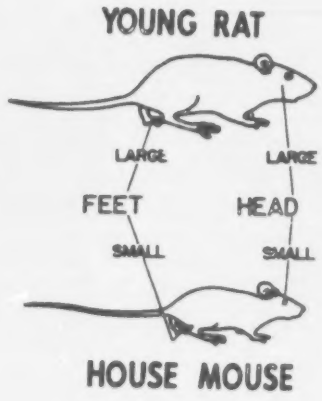


Fig. 63. Comparison of Young Rat and House Mouse

The presence of these rats may also be determined by locating other signs. The droppings, for example, are 3/8 to 3/4 of an inch long, somewhat pointed on each end, and may be found along runways or feeding sites. Dark greasy smears made by continual rubbing may also indicate the presence of rats. Norway rats prefer to burrow and nest in the ground and the presence of these is another sign of rat infestations. In addition, tracks, urine stains, hair, sounds of activity, gnaw marks, and a characteristic "musty" odor may also indicate the presence of rats.

After mating, a litter of rats may be born in just over three weeks. The average litter size is 8 or 9 individuals. At this rate, the Norway rat could produce about 12 litters or about 100 individuals per year. For a variety of reasons, only about 4-5 litters are produced and 2/3 of these young do not survive. Even at this high mortality rate, rat populations may build up rapidly. The surviving young depend on their mother for up to 5 weeks. They become sexually mature at 2 to 3 months. Rats live 9 months to about a year.

Rats possess excellent balance and keen senses of hearing, taste, smell, and touch. Their sense of eyesight is poorly developed.

Habits and Habitats:

The Norway rat is normally a social, burrowing, ground-nesting rodent. When associated with man-made structures, preferred nesting sites include basements and crawl spaces with dirt floors. This species is nocturnal and when food is abundant, exhibits greatest feeding activity during the first half of the night. Rats normally consume only one kind of food at a feeding. They are cautious and avoid anything new or strange in their environment. Rats may become active during the day under overcrowded conditions or if food is scarce. When not active, rats require places to hide and nest. The harborages and nesting sites should be located in a rodent inspection. Common harborages include wall, floor, and ceiling voids, improperly constructed food storage or work areas, and piles of stored products.

Rats readily move from place to place and may travel distances of 150 feet or more. If easy access to a building is not available, rats will gnaw new openings or increase the size of existing ones to gain entrance. Rats are excellent climbers using pipes, electrical wires, clinging vines, and even brick or stucco walls to gain entry to a building. They have the ability to reach or span obstacles which are over 12 inches high or may jump vertical distances of two feet or more. Norway rats are good swimmers and often use sewer systems to travel between buildings. Rats will move considerable distances from their nests or harborages to obtain food or water. Therefore, rat activity within a building does not always mean that the rat population lives within the building.

House Mouse

Description and Biology:

The house mouse is a small grayish rodent which reaches about 3 inches in length when fully grown. Their droppings are much smaller than those of rats and are more pointed on one end.

Fig. 64. House Mouse

The biology of the house mouse is very similar to that of rats and will be considered the same for our purposes here. Only minor differences occur with respect to the number of young per litter, number of litters per year, the length of the gestation period, and the length of time to maturity.

Habits and Habitats:

Unlike rats, mice do not live in colonies but remain in more or less defined territories. These territories are usually established in areas where food is readily available. Mice visit their territories on a daily basis. Mice also do not need a constant source of water and do quite well on the water they obtain from their food. As a result, house mice do not travel very far from their nests. Their small size enables them to hide in or move through very small openings. A young mouse needs scarcely more than a 1/4 inch space to pass through. Mice are curious by nature and will readily explore changes in their environment. They are "nibblers" and will feed on a variety of foods at each feeding. Mice are also nocturnal.

The house mouse nests in wall and ceiling voids, behind applicances and

cabinets, and when a problem in warehouses or grain storage areas, this pest may actually nest within sacks of feed. Mice have the habit of lining their nests with soft material such as paper, cloth and upholstering and may do extensive damage to furniture or stored product sacks.

CONTROL

The control of a single house mouse or rat may be a fairly simple task. However, controlling large infestations of these rodents may require considerable knowledge of their biology and behavior, a number of control methods, and some ingenuity.

Sanitation

By far the most important part of any rodent control program involves proper sanitation. The removal of the rodent's water and food sources such as open or inadequate garbage and trash receptacles either in homes or business establishments and the elimination of harborages is often effective in preventing rodent infestations. After current infestations are controlled, these principles are important in preventing reinfestations.

Exclusion

Rats and mice can gain access to a building through very small openings. Therefore,a keen eye and knowledge of rodent behavior is necessary during inspections to locate these routes of entry. Exclusion or "rat-proofing" involves altering the structure of a building to prevent entry by rodents. Some of these procedures involve patching loose or broken concrete, screening windows or vents, or installing metal guards around pipes, doors, or electrical wires. Exclusion may best be accomplished during the construction of a building.

Rodenticides

Rats and mice will feed on almost anything that man and domestic animals eat; this fact becomes a useful tool in rodent control. By locating the rodent's sources of food and water, eliminating them, and substituting poison baits (solid or liquid) in their places, rodent populations may be temporarily reduced.

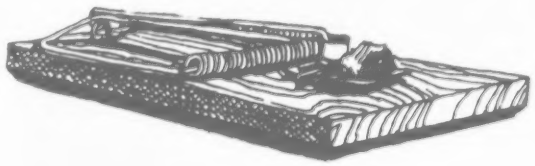
The various rodenticides used are divided into two groups. The conventional type of rodenticide acts by directly poisoning the rodent, usually as a result of their feeding. Some common rodenticides include Red Squill, Antu, phosphorous, arsenic trioxide, and zinc phosphide. Depending on the rodenticide, they may be used as baits or tracking powders and placed around suspected runways and feeding sites. Selection of the proper rodenticide may make quite a difference in the overall success of the control program. Consideration should be given to the area to be treated, against what rodents is the material effective, the number of times and the interval between uses before bait shyness may become a problem, the kind of control approach used (routine maintenance vs short-term corrective measures), the hazard to children and pets (secondary poisoning), and whether the unused rodenticide must be recovered.

The second type of rodenticide is the anticoagulants. These materials such as Pival, Warfarin, Diphacin, PMP, and Fumarin are not acute toxicants but act by interfering with the normal mechanism of blood clotting in the rodent. Anticoagulants may be used as baits and tracking powders. Repeated feedings are required for effective control. These rodenticides are generally thought of as being fairly safe since a child or pet would have to eat a considerable amount of the anticoagulant over a period of time to be affected. Despite this, safety precautions are still essential when using these materials.

Trapping

Trapping is another technique often used in rodent control. The traps used include various types of cage or box traps, snap or jump traps, and glues. By far the most common and successful trap is the wooden-based snap trap. These traps should be placed in areas normally visited by the rodents. When placed near a wall, the traps should be set perpendicular to the wall with the bait pan nearest the wall.

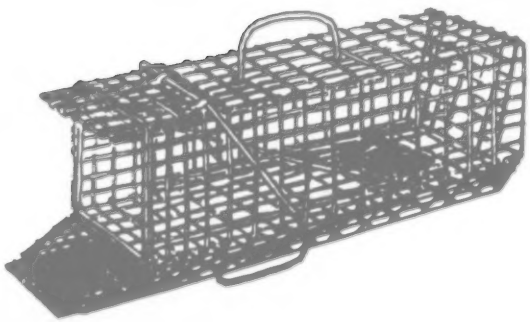
Fig. 65. Snap Trap



Other important aspects of trapping include the number of traps to be used, the length of time the trapping program should run, the type of rodent to be controlled, and the potential hazards to small children and pets.

A second kind of trapping method involves the use of box or cage traps. Unlike the snap traps, the box or cage trap does not harm the animal. For controlling large populations of rats and mice, this method is impractical since considerably more time must be spent transporting and destroying the live rodents.

Fig. 66. Cage Trap



A third trapping technique involves the use of glues. These sticky materials are applied to various types of heavy paper or wood and placed along runways or other areas often visited by the rodents. When contacting the "glue board", the

rodents becomes entangled and eventually die. The use of glue may be a messy procedure and even under the best conditions is only marginally effective.

The success of any trapping program largely depends on knowing the behavior of the pest. Rats are more cautious or suspicious and they may tend to avoid traps at first. Therefore, the length of time the traps remain in place is important. Mice on the otherhand, are very curious by nature and will readily investigate new objects such as traps. The daily moving of traps or other objects in the mouse's environment may play on the mouse's curiosity and improve the success of the program. Changing the rat's environment will have the opposite effect. Since mice establish territories and are generally only active in these areas, a greater number of traps are required to be sure all areas inhabited by the mice are covered.

The acceptance of baits by rats vs mice closely follows a similar pattern. Rats will take longer to accept baits but once they do, they will eat large quantities of the bait at one time. Mice will readily accept new bait but because they eat only small quantities of food at a time, repeated feedings or larger concentrations of poison in the bait may be necessary to cause death. Rats require free drinking water daily. Eliminating or at least reducing their water sources should increase the effectiveness of liquid baits. This procedure may not be very effective against mice since their water requirement is not as great. The success of your baiting program depends on knowing your pest!

BATS

Bats are the only true mammals that fly. They are predaceous, feeding almost exclusively on flying insects. Their droppings contain insect fragments. Bats become pests when they roost singly or in groups in attics, barns, wall

voids and other vacant structures. Their presence, odor, and noise may be objectionable to some people. On occasion, bats may bite and sometimes transmit rabies, and thus become a health problem. Bats observed fluttering aimlessly on the ground or acting in an abnormal manner should be approached with caution or avoided and reported to health officials. Because they feed on insects, bats are considered beneficial and should not be destroyed needlessly.

Bats vary in size (body length 3-5 inches) and coloration which ranges from silvery-gray to dark brown. Except for their leathery wings, bats are completely covered with fur.

Bats are nocturnal and are active between dusk and dawn in warm weather. Control is best achieved by blocking their access to the building (exclusion). All openings larger than 1/4 of an inch must be closed. Some species of bats cannot overwinter in unheated buildings and will migrate to warmer regions when cold weather approaches. Thus, exclusion may be most successful if attempted in early spring or late fall. Any exclusion attempts should be made after the bats have left the roost for the evening.

SQUIRRELS

Squirrels become pests when they enter attics, other areas which are seldom used, or unoccupied buildings. The major objections to their presence is the odor from the urine and feces, noise, gnawing, damage to gardens, and their harboring of ectoparasites.

Squirrels are familiar to most everyone. They feed mostly on nuts, grain, seeds, fruit, and some crops. Damaged crops, partially eaten nuts, fruit, and seeds, nesting material, droppings and gnawed holes indicate their presence. Squirrels have at least one litter per year, usually in the spring.

The litters range in size from 2-7 individuals. A second litter may be produced in the fall. Squirrels may be protected by law in some areas and local game wardens or wildlife agencies should be consulted before control procedures are begun. Exclusion is an effective means of control.

MOLES

Moles are subterranean mammals which burrow several inches below ground and cause damage to lawns, golf courses, and gardens. Their presence may be detected by locating burrows, mounds, runways and damaged flowers and vegetables.

Moles rarely venture above ground and feed almost exclusively on earthworms, beetle grubs, and other ground dwelling insects. The reduction of these ground dwelling insects may discourage mole infestations in turf areas. Moles usually have a single litter of 3-6 individuals per year. Spike traps or baits placed in the burrows can give control.

SKUNKS

Skunks occasionally become pests by living near or beneath residences. Although the chief objection to their presence may be the penetrating odor they are notoriously capable of producing, skunks are able to transmit rabies. Skunks that exhibit aggressive behavior or act in an otherwise abnormal fashion, should be avoided. Report such incidences to local health officials.

Skunks are familar to most people but are only occasionally seen because they are nocturnal. They feed on insects, small rodents and birds, fruits, seeds and are sometimes associated with garbage dumps or landfills. Skunks may have 1-2 litters per year of up to 4 young per litter. Adults may live 6 years.

Exclusion may not be very effective in controlling skunks since they

are excellent burrowers and can easily dig another entrance. However, several attempts at exclusion may discourage them. Skunks are protected game animals in many areas and local game officials should be consulted before control attempts are initiated. Control methods which kill or injure skunks often result in an odor problem. Skunks and other small mammals may be trapped in box or cage traps and released elsewhere.

SNAKES

Snakes more than most animals tend to frighten people and are thus considered pests. Occasionally they will enter secluded parts of buildings to escape the hot part of the day; to seek food such as rodents, birds, and insects; or to hibernate during the winter. In general, snakes native to New Jersey are harmless or even beneficial with only two species, the copperhead and rattlesnake, being poisonous. Signs of snakes include shed skins and droppings which are similar in appearance to those of large birds.

Characteristics used to separate poisonous and non-poisonous snakes are fairly obvious but may require close examination. Poisonous snakes have ellyptical eye pupils, small pits located between their eyes and nostrils, and individual scales on the underside of their tails while non-poisonous snakes have round eye pupils, no pits, and divided scales, respectively.

Presently, no pesticide or repellents are registered for snake control. Removal of debris around buildings will make these areas unattractive to them. Control of food sources such as mice or rats within buildings may discourage snake infestations. Exclusion is an effective method of control.

BIRDS

Several species of birds may become pests as a result of roosting or nesting in or near buildings. Aside from the objectionable noise and droppings of these birds, many harbor ectoparasites such as mites which may attempt to feed upon man after the nest or roost is abandoned.

ENGLISH OR HOUSE SPARROW

These small birds are brownish-gray in color with the male exhibiting white cheeks and a black throat. They may produce up to three generations per year with an average of 4-7 individuals per brood. English sparrows are highly competitive birds and often drive out more desirable species. Nesting in eaves and gutters often results in clogged drains and downspouts.

STARLINGS

Starlings are dark colored, stout-bodied birds of intermediate size. Their feathers are flecked with iridescent purple and green colors and their bills are yellow. In some respects they are important to agriculture because they feed upon soil dwelling pests. They also eat seeds and may damage fruit. Starlings usually produce 2 broods per year, each containing about 6 individuals. Starlings become nuisance pests because of the excess noise and droppings when they roost together in large numbers. They leave the roost early in the day and return in the evening.

PIGEONS

Large populations of pigeons may become a nuisance, especially in urban areas. Heavy concentrations of pigeons may become a health hazard because they are carriers of several animal and human diseases.

Although none of these birds are protected by federal laws, local statutes

may prohibit their destruction. These birds may be eliminated or discouraged from roosting and/or nesting by exclusion, nest or roost removal, frightening devices, and trapping or shooting. Only a few pesticides are registered for bird control. The method used largely depends upon the extent of the problem and local laws. When nests occur on or within buildings, they should be removed soon after the fledglings leave and the area treated with a labeled pesticide to prevent their ectoparasites from entering the building and annoying man.

RUTGERS
THE STATE UNIVERSITY
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GENERAL AND HOUSEHOLD PESTS

STUDY QUESTIONS FOR COMMERCIAL PESTICIDE APPLICATORS

Office of Pesticide Applicator Training

COOPERATIVE EXTENSION SERVICE / COOK COLLEGE

COORDINATED AND EDITED

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INTRODUCTION

This category Study Questions Leaflet is for the use of the commercial pesticide applicator preparing for certification as required by federal and state pesticide regulations. The main objective in providing this publication to pesticide users and applicators is to insure the proper and safe use of these chemicals. By putting to use the best technology in applying pesticides we know significant benefits are possible for the applicator as well as the environment. Greater economy, more efficiency in pest control, less risk of hazards, and less time needed in the application of pesticides are some of the benefits available to applicators participating in training for certification.

The multiple choice and true-false questions relate to the main points in the category area of pesticide application and should be studied with reference to the Pesticide Applicator Training Manual. Study and complete each chapter before going to the next. Answer the Category Study Questions by choosing the best answer. Refer to the key for the correct answers.

The following suggestions may be helpful in the study of these Category Study Questions and associated Pesticide Applicator Training Category Manual:

1. Try to be in a positive frame of mind that these materials can be of considerable help to you.

2. Pick a quiet place to study and a time when two or more chapters can be studied at one sitting.

3. Do not memorize. Try to understand the idea and/or principle back of each question.

4. Additional help is as close as your telephone. If you do not understand some questions, your County Agents, specialists, fieldmen, and others may be able to help. Sign up for a training session for pesticide applicators.

5. Do not cram. Choose regular times for study.

6. A training school may be available in your county or area. Call your County Extension Office for information.

7. Relax and be confident when you take the exam.

CERTIFICATION CAN BE THE STAMP OF PROFESSIONALISM IN YOUR WORK

ANTS

1) Which one of these ants causes structural damage? a( ) b( )
   a. pavement ants
   b. carpenter ants
   c. yellow ants
   d. pharaoh's ants c( ) d( )

2) Unlike termites, ants never produce swarmers. T( ) F( )

3) Which of the following is not a caste in an ant colony? a( ) b( )
   a. queen
   b. soldier
   c. worker
   d. winged reproductives c( ) d( )

4) The most effective chemical approach in controlling carpenter ants is the use of: a( ) b( )
   a. baits.
   b. residual sprays.
   c. space sprays. c( ) d( )
   d. dusts.

5) The purpose of ants swarming is to establish new colonies. T( ) F( )

6) Which of the following characteristics is <u>not</u> true for ants? a( ) b( )
   a. wings of unequal length
   b. elbowed antennae c( ) d( )
   c. constricted "waist"
   d. wings of equal length

7) For complete control of ants it is always necessary to locate the nest. T( ) F( )

8) Which ant is most frequently associated with interior wall voids of a structure, particularly in big buildings? a( ) b( )
   a. pavement ant
   b. yellow ant
   c. pharoah's ant c( )

9) Baits are more effective for "trail laying" ants than for ants which do not make chemical trails. T( ) F( )

10) The most common ant which lives under sidewalks and concrete slabs is the: a( ) b( )
   a. pavement ant.
   b. yellow ant.
   c. pharoah's ant. c( ) d( )
   d. fire ant.

11) Which of the following ants can be distinguished by its citronella-like odor: a( ) b( )
   a. pharoah's ant
   b. larger yellow ant
   c. pavement ant c( ) d( )
   d. carpenter ant

12) Yellow ants live in the soil and are seldom encountered until they swarm. T( ) F( )

13) When pavement ants are found indoors, their nests are frequently associated with: a( ) b( )
   a. foundation walls. c. either of the above. c( ) d( )
   b. concrete slabs. d. none of the above.

14) Which of the following ants nest in and damage wood? a( ) b( )
   a. pharoah's ant c. carpenter ant
   b. pavement ant d. yellow ant c( ) d( )

15) Carpenter ant nests are often found in wood that has been damaged by water leakage. T( ) F( )

16) Carpenter ants nest in logs and stumps as well as in wall voids and hollow doors. T( ) F( )

17) Carpenter ant galleries, like termite galleries contain mud and fecal matter. T( ) F( )

18) Which of the following clues are often associated with a carpenter ant infestation? a( ) b( )
   a. dead workers or swarmers concentrated in a secluded area of the attic c( ) d( )
   b. damaged wood having clean tunnels and no debris
   c. shredded pieces of coarse sawdust hanging in a cobweb
   d. all of the above

19) Carpenter ant pupae are encased in a tan silken cocoon and are sometimes found under insulation, in void areas, or in portions of damaged wood. T( ) F( )

20) Carpenter ants: a( ) b( )
   a. may travel hundreds of feet from the nest.
   b. may stay within 50 feet of the nest. c( )
   c. may seldom travel more than 10 feet.

21) Ants are not pests during the winter because the colonies die out. T( ) F( )

T( ) F( )

KEY

1.	b	7.	F	13.	c	19.	T
2.	F	8.	c	14.	c	20.	a
3.	b	9.	T	15.	T	21.	F
4.	d	10.	a	16.	T		
5.	T	11.	b	17.	F		
6.	d	12.	T	18.	d		

BEES, WASPS, HORNETS

1) The presence of carpenter bees may be determined by locating: a( ) b( )
   a. paper nests hanging from eaves. c( )
   b. ½" diameter holes "drilled" in overhangs and siding.
   c. a number of holes in a lawn.

2) Honey bees are beneficial insects because they: a( ) b( )
   a. are natural enemies of a variety of pests.
   b. are pollinators of many flowers and crops. c( )
   c. keep tresspassers away.

3) The wasp most likely to sting is: a( ) b( )
   a. the yellow jacket.
   b. the cicada killer. c( )
   c. the mud dauber wasp.

4) Many mud dauber wasps are commonly seen around moist places such as mud puddles because: a( ) b( )
   a. they need quantities of water to drink during the hot summer months. c( )
   b. they need mud to build their nests.
   c. they provision their nests exclusively with aquatic insects.

5) The major problem with large numbers of carpenter bees is that they: a( ) b( )
   a. will attack and sting people without reason. c( )
   b. may weaken wooden structures by their nest building.
   c. transmit several plant diseases.

6) Carpenter bee is another name for bumble bee. T( ) F( )

7) Plugging the entrance hole of bee or yellow jacket nests will solve the problem. T( ) F( )

8) The mud dauber is a: a( ) b( )
   a. social wasp. c. solitary wasp.
   b. solitary bee. d. social bee. c( ) d( )

9) An example of social bees are: a( ) b( )
   a. spelling bees. c. honey bees.
   b. carpenter bees. d. none of the above. c( ) d( )

10) Swarming honey bees are very violent and will sting with little or no provocation. T( ) F( )

BWH2

11) All bees, wasps, and hornets are social insects (live in colonies). T( ) F( )

12) Bee and wasp stings can be fatal. T( ) F( )

13) Wasps overwinter as adult reproductive females (queens). T( ) F( )

14) Cicada killers nest in: a( ) b( )
   a. lawns.
   b. holes in trees.
   c. walls of houses. c( )

15) The bald-faced hornets overwinter in their paper nests and removing the nest during the winter will give complete control. T( ) F( )

16) It is best to treat wasp and hornet nests at night because: a( ) b( )
   a. all the workers are home.
   b. they cannot see well in the dark.
   c. they will not sting at night. c( )

17) The bald-faced hornet usually makes: a( ) b( )
   a. a large multi-layered comb with paper covering.
   b. an exposed single layered comb nest. c( ) d( )
   c. a wax comb nest.
   d. none of the above.

18) To avoid such problems as honey leaking out and staining walls, it is best to control honey bees: a( ) b( )
   a. in the Fall.
   b. in the Spring. c( )
   c. it doesn't matter.

KEY

1. b
2. b
3. a
4. b
5. b
6. F
7. F
8. c
9. c
10. F
11. F
12. T
13. T
14. a
15. F
16. a
17. a
18. b

COCKROACHES

1) The presence of cockroaches, even without seeing any, can be determined by locating: a( ) b( )
   a. cast skins of the nymphs.
   b. empty or full egg cases.
   c. droppings. c( ) d( )
   d. all of the above.

2) The chief economic importance of cockroaches involves: a( ) b( )
   a. direct disease transmission.
   b. contamination of food products. c( )
   c. consumption of large quantities of food products.

3) The cockroach which carries the egg case around with it until just before hatching is the: a( ) b( )
   a. brown-banded cockroach.
   b. Oriental cockroach.
   c. German cockroach. c( ) d( )
   d. all of the above.

4) The cockroach which has 2 dark bands on the shield immediately behind the head is the: a( ) b( )
   a. brown-banded cockroach.
   b. German Cockroach.
   c. Oriental cockroach nymph. c( ) d( )
   d. American cockroach.

5) Brown-banded cockroaches are frequently found in rooms other than kitchens or bathrooms because: a( ) b( )
   a. they don't need as much moisture. c( )
   b. they don't need as much food.
   c. there are more hiding places elsewhere.

6) The adult female cockroach which is large, dark brown to black in color, and does not have fully developed wings is the: a( ) b( )
   a. brown-banded cockroach.
   b. Oriental cockroach.
   c. American cockroach. c( )

7) The cockroaches which most often attach their egg cases to objects are the: a( ) b( )
   a. brown-banded cockroaches.
   b. American cockroaches.
   c. wood cockroaches. c( ) d( )
   d. German cockroaches.

8) The cockroaches which prefer warm, moist areas and are usually found in basements and crawl spaces are: a( ) b( )
   a. German cockroaches.
   b. brown-banded cockroaches.
   c. American cockroaches. c( )

9) The difference between American cockroach and mouse droppings is: a( ) b( )
   a. mouse droppings are at least twice as large. c( ) d( )
   b. American cockroach droppings have blunt ends and light colored ridges running from end to end while mouse droppings are pointed on one end.
   c. American cockroach droppings are pointed on both ends while mouse droppings are blunt on both ends.
   d. no difference.

10) The effectiveness of which of the following applications is most dependant upon the surface on which it is applied? a( ) b( )
   a. pellet baits
   b. dusts
   c. ULV treatments
   d. mist treatments
   c( ) d( )

11) Space treatment for cockroaches is more effective when used: a( ) b( )
   a. with baits.
   b. after residual spray treatments.
   c. with a flushing agent.
   d. alone.
   c( ) d( )

12) Knockdown action means that an insecticide: a( ) b( )
   a. stuns a roach.
   b. kills a roach.
   c. both.
   c( )

13) It is most important for a dust to have: a( ) b( )
   a. quick knockdown.
   b. flushing action.
   c. ability to attract cockroaches.
   d. a long residual life.
   c( ) d( )

14) Which of the following has the longest residual life in control of cockroaches? a( ) b( )
   a. dusts
   b. residual sprays
   c. space treatments
   c( )

15) Which of the following is not true of dusts? a( ) b( )
   a. Dusts get into voids and deep into cracks.
   b. Dusts usually have the longest residual life.
   c. Dusts are effective if applied lightly.
   d. Dusts work well in damp areas.
   c( ) d( )

16) When selecting a chemical for the control of German cockroaches in a food establishment the most important thing to consider is: a( ) b( )
   a. cost.
   b. odor.
   c. is chemical labeled for this use.
   d. results.
   c( ) d( )

17) Space treatment in a building refers to the: a( ) b( )
   a. dispersal of insecticides into the air.
   b. application of a wet spray for immediate insecticidal effect.
   c. application directly to broad expanses or surfaces.
   d. application to limited areas on which insects are likely to occur.
   c( ) d( )

18) Crack and crevice treatment is: a( ) b( ) c( )
   a. the application of small amounts of insecticides into cracks and crevices above and below areas where food is stored or prepared.
   b. the application to broad expanses of surfaces.
   c. the application of small amounts of insecticides into cracks and crevices in which insects hide or through which they may enter the building and where food contamination will not occur.

19) When treating with an insecticide for cockroaches in a food area of a restaurant the: a( ) b( ) c( )
   a. area of the restaurant being treated should be closed.
   b. food stuffs should be removed, covered, or placed in proper containers.
   c. all the above

20) The following item which does <u>not</u> have to be recorded in your service records is the: a( ) b( ) c( ) d( )
   a. name of product used.
   b. concentration of pesticide in the formulation applied.
   c. date application was made.
   d. chemical manufacturer.

21) Spot treatment is the: a( ) b( ) c( )
   a. application of small amounts of insecticides into cracks and crevices in which insects hide.
   b. application of insecticides to limited areas on which insects are likely to occur, but which will not be in contact with food or utensils.
   c. use of an insecticide which spots surfaces.

22) The first step in preventing cockroach infestations in an establishment involves: a( ) b( ) c( )
   a. employing an expert.
   b. proper sanitation practices.
   c. proper chemical selection.

23) If cockroaches are found in a night table in a hospital patients room, you should: a( ) b( ) c( ) d( )
   a. use a dust.
   b. use a residual spray.
   c. remove night table and treat
   d. all of the above are acceptable.

24) Which of the following is a disadvantage of dusts? a( ) b( ) c( ) d( )
   a. Dusts have little odor.
   b. Dusts have long residual.
   c. Dusts have uniform composition.
   d. Dusts cake in high humidity.

25) A pesticide mixed with a food as an attractant is a: a( ) b( )
   a. dust. c. aerosol.
   b. bait. d. glue board. c( ) d( )

26) In crack and crevice treatments for cockroaches the area which is not considered a food area is the: a( ) b( )
   a. kitchen. c. food storage area. c( ) d( )
   b. garbage area. d. restaurant serving area.

27) An example of a mixture of active ingredients + solvent + emulsifier + inert ingredients is: a( ) b( )
   a. 6G. c. 4F c( ) d( )
   b. 10D. d. 2E

28) One disadvantage of using poison bait for cockroach control is: a( ) b( )
   a. the relatively small amount of toxicant.
   b. the contamination of food. c( )
   c. it must be recovered and removed in most cases.

29) Dusts or powders should not be used in heating ducts for cockroach control <u>mainly</u> because: a( ) b( )
   a. of a possible fire hazard. c( )
   b. of an odor problem.
   c. they may move off target.

30) Which of the following has the shortest residual? a( ) b( )
   a. dusts c. baits
   b. space sprays c( )

31) The use of a flushing agent alone usually gives adequate cockroach control. T( ) F( )

32) Which of the following applications may be hazardous when applied around electric motors? a( ) b( )
   a. dust c. bait c( ) d( )
   b. water-based residual spray d. granular

33) Which of the following formulations can be used in food areas only if the food handling establishment is not in operation? a( ) b( )
   a. baits c. residual sprays c( ) d( )
   b. dusts d. space sprays

34) Which of the following cockroaches multiplies the fastest? a( ) b( )
   a. German cockroach c. American cockroach
   b. Oriental cockroach c( )

35) In what situation would it be most hazardous to use a residual spray which contained a flammable solvent? a( ) b( )
   a. around a sink area c. in cracks and crevices c( ) d( )
   b. around a gas stove d. around a toilet

36) Which of the following applications may be hazardous when applied around gas appliances? a( ) b( )

a. dusts
b. water-based residual sprays
c. oil-based residual sprays c( ) d( )
d. baits

1.	d	13.	d	25.	b
2.	b	14.	a	26.	b
3.	c	15.	d	27.	d
4.	b	16.	c	28.	c
5.	a	17.	a	29.	c
6.	b	18.	c	30.	b
7.	a	19.	c	31.	F
8.	c	20.	d	32.	b
9.	b	21.	b	33.	d
10.	b	22.	b	34.	a
11.	b	23.	c	35.	b
12.	a	24.	d	36.	c

FLEAS

1) After treating the residence for fleas, the applicator should treat the infested animal with any left over spray. T( ) F( )

2) The only difference in appearance between adult and immature fleas is that the adults have wings while the immatures are wingless. T( ) F( )

3) In considering fleas, only adults feed on the host animal. T( ) F( )

4) Removing the infested pet for several days will insure control since the adult fleas must feed at least once a day. T( ) F( )

5) The cat flea will readily feed on: a( ) b( )
   a. cats.
   b. dogs.
   c. humans.
   d. all of the above. c( ) d( )

6) Adult fleas feed on: a( ) b( )
   a. decaying organic matter.
   b. dry skin flakes on the host.
   c. blood. c( )

7) The most effective way to control fleas is to: a( ) b( )
   a. begin an extensive chemical control program.
   b. recommend a sound sanitation or "clean-up" program (washing or destroying animal bedding, vacuuming infested areas, etc.). c( ) d( )
   c. remove the pet.
   d. destroy the pet.

8) It is possible for fleas to multiply outside during the summer months. T( ) F( )

9) Flea larvae are most likely to be found: a( ) b( )
   a. in cupboards.
   b. behind baseboards.
   c. in hollow doors.
   d. in pet beds, rugs, or upholstered furniture. c( ) d( )

10) Larval fleas feed on: a( ) b( )
   a. flakes of skin from the host.
   b. fecal droppings of the adult fleas. c( ) d( )
   c. crumbs of dog food.
   d. all of the above.

11) Dog and cat fleas should be controlled because they: a( ) b( )
   a. carry a variety of human diseases in New Jersey.
   b. are a nuisance to people and pets. c( )
   c. can cause severe structural damage to some furnishings.

KEY

1. F
2. F
3. T
4. F
5. d
6. c
7. b
8. T
9. d
10. d
11. a

FLIES

1) Of those listed below, the fly which does not bite is the: a( ) b( )
   a. stable fly.
   b. house fly.
   c. deer fly.
   d. horse fly. c( ) d( )

2) House fly larvae (maggots) are: a( ) b( )
   a. similar in appearance to adults but do not have wings.
   b. cream-colored and wormlike in appearance. c( )
   c. flattened from top to bottom and are covered with spines.

3) In which of the following places would house fly maggots not be found? a( ) b( )
   a. moist straw or hay
   b. garbage
   c. animal manure c( ) d( )
   d. in mud near a stream bank

4) An adult female house fly may live 1 to 2 months and lay more than 1000 eggs during this period. T( ) F( )

5) When house flies occur around stables or other livestock areas, they are called stable flies. T( ) F( )

6) The most fundamental approach to fly control is: a( ) b( )
   a. sound sanitation practices.
   b. a total chemical approach. c( )
   c. the exclusive use of pest control strips.

7) An example of an integrated approach to fly control might be the use of: a( ) b( )
   a. a space spray and a residual insecticide. c( ) d( )
   b. proper sanitation practices, an insecticide and screening.
   c. a fly swatter and screening.
   d. a broom and animal excrement disposal.

8) If you, as an applicator, received a call from a customer complaining about small "fuzzy" insects coming from a floor or sink drain, you might expect the pest to be: a( ) b( ) c( ) d( )
   a. moth flies.
   b. cockroaches.
   c. house flies.
   d. spiders.

9) If a customer called one winter day and complained about "a bunch of flies lying around in the attic" you would probably recommend: a( ) b( ) c( )
   a. no control because they are surely dead.
   b. dispose of them because they may just be hibernating.
   c. installing screens in the attic.

10) Like the house fly and its relatives, black flies and deer flies breed in garbage and manure. T( ) F( )

11) The first step in controlling moth (filter) flies in private residences is to thoroughly clean and/or repair all drain pipes and traps. T( ) F( )

12) Flies which are metallic blue, green or copper in color are most likely: a( ) b( )

a. flesh flies.
b. blow flies.
c. deer flies. c( ) d( )
d. house flies.

13) Which characteristic(s) would be useful in differentiating flesh flies and house flies? a( ) b( )

a. the abdomen of flesh flies is checkered in appearance c( ) d( )
b. flesh flies are generally larger
c. the thorax of flesh flies is marked with 3 dark longitudinal stripes
d. all of the above

14) Which of the following would most likely not be found in moist soil or decaying plant material near a shoreline? a( ) b( )

a. deer fly larvae
b. house fly maggots
c. stable fly maggots c( ) d( )
d. no-see-ums

15) The larvae of which of the following species is different in appearance from the others? a( ) b( )

a. house fly
b. stable fly
c. lesser house fly c( ) d( )
d. face fly

16) House flies are not able to spread disease because they cannot bite. T( ) F( )

17) Since house flies have many generations per year, a single chemical treatment will probably not give adequate control for the entire season. T( ) F( )

18) Screening is not effective in keeping out: a( ) b( )

a. blow flies.
b. stable flies.
c. no-see ums. c( ) d( )
d. horse flies.

19) All flies:

a. exhibit complete metamorphosis. a( ) b( )
b. have one pair of wings.
c. belong to the order Diptera. c( ) d( )
d. all of the above.

KEY

1. b
2. b
3. d
4. T
5. F
6. a
7. b
8. a
9. b
10. F
11. T
12. b
13. d
14. b
15. c
16. F
17. T
18. c
19. d

LABELING

Using the two specimen labels (Diazinon 4E and Dursban 2E) answer the following multiple choice and true-false questions by choosing the best answer.

1) Dursban 2E can be used by both the general public and the certified applicator. T( ) F( )

2) For tick control, Dursban 2E is registered for use indoors as well as outdoors. T( ) F( )

3) Registration for which of the following Dursban 2E uses is <u>not</u> indicated on the label? a( ) b( )
   a. outdoors for brown dog ticks c( ) d( )
   b. broadcast (general) treatment for spiders
   c. crack and crevice treatment for cockroaches
   d. whiteflies on rhododendrons

4) Dursban 2E can be used in restuarant kitchens. T( ) F( )

5) Chlorpyrifos is the: a( ) b( )
   a. chemical name. c. trade name.
   b. common name. c( )

6) When mixed with water, Dursban 2E forms: a( ) b( )
   a. a suspension. c. an emulsion.
   b. a solution. d. all of the above. c( ) d( )

7) According to the Dursban 2E label, both oil-base and water-base sprays can be used indoors. T( ) F( )

8) To make up 60 gallons of a 0.5% oil-base Dursban spray the amount of Dursban 2E needed is approximately: a( ) b( )
   a. 1 quart. c 4 quarts. c( ) d( )
   b. 2 quarts. d. 6 quarts.

9) To treat 8,000 sq. ft. of lawn for chinch bugs the quantity of Dursban 2E needed is: a( ) b( )
   a. $\frac{1}{2}$ pint. c. 3/4 pint. c( ) d( )
   b. 2/3 pint. d. 1 pint.

10) Blood testing for cholinesterase levels is one possible way to determine excessive exposure to Dursban 2E. T( ) F( )

11) The active ingredients of Dursban 2E amount to: a( ) b( )
   a. 22.4% c. 35.5%
   b. 42.1% d. 64.5% c( ) d( )

12) The active ingredients of Dursban 2E include(s): a( ) b( ) c( ) d( )
   a. Dursban only.
   b. chlorpyrifos only.
   c. both dursban and chlorpyrifos.
   d. both chlorpyrifos and solvent.

13) The Dursban 2E label states that under some circumstances a respirator should be worn by the applicator. T( ) F( )

14) The pesticide labeling is a legal document. T( ) F( )

15) In New Jersey all registered applicators may use Diazinon 4E. T( ) F( )

16) The labeling of Diazinon 4E contains all the necessary information for proper and safe use by certified commercial applicators. T( ) F( )

17) Both Diazinon 4E and Dursban 2E are classified as: a( ) b( ) c( ) d( )
   a. highly toxic.
   b. moderately toxic.
   c. slightly.
   d. very low toxicity.

18) To prepare a spray mixture the Diazinon 4E label instructions provide for mixing with either oil or water. T( ) F( )

19) The trade name of this diazinon formulation is: a( ) b( ) c( ) d( )
   a. Residex.
   b. Diazinon 4E
   c. O, O-Diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl phosphorothioate.
   d. Residex Brand Diazinon 4E.

20) According to the label directions the amount of Diazinon 4E needed to make 15 gallons of spray for the initial (first) application to a heavy cockroach population is approximately: a( ) b( ) c( ) d( )
   a. 13 oz.
   b. 19 oz.
   c. 38 oz.
   d. 57 oz.

21) Directions for the control of mosquitos are given: a( ) b( ) c( ) d( )
   a. only on the diazinon label.
   b. only on the dursban label.
   c. on both diazinon and dursban labels.
   d. on neither label.

22) Atropine as an antidote for organophosphate insecticide poisoning is indicated on both the diazinon and dursban labels. T( ) F( )

23) For the control of flour beetles and meal moths it would be best to follow the directions of the: a( ) b( )
   a. Diazinon 4E label.
   b. Dursban 2E label.

24) Both Diazinon 4E and Dursban 2E are readily absorbed through the skin of the applicator. T( ) F( )

25) Disposal directions are given on: a( ) b( )
a. only the Diazinon 4E label.
b. only the Dursban 2E label.
c. both the Diazinon 4E and Dursban 2E labels. c( )

26) The EPA registration No. 373-109 was granted to: a( ) b( )
a. Ciba-Geigy Corp.
b. Residex Corp.

27) According to the labeling directions for Dursban 2E and Diazinon 4E to make up a 0.5% spray for the control of household pests it requires: a( ) b( ) c( )
a. about twice as much Dursban 2E as Diazinon 4E.
b. about the same amount of Dursban 2E as Diazinon 4E.
c. about 1/2 as much Dursban 2E as Diazinon 4E.

KEY

1.	F	10.	T	19.	d
2.	T	11.	d	20.	c
3.	b	12.	d	21.	b
4.	T	13.	F	22.	F
5.	b	14.	T	23.	a
6.	c	15.	F	24.	T
7.	T	16.	T	25.	c
8.	c	17.	b	26.	b
9.	c	18.	F	27.	a

MINOR PESTS

1) Most spiders are considered beneficial because they feed primarily on insects and related animals. T( ) F( )

2) The poisonous spider most commonly a problem in New Jersey is the: a( ) b( )
   a. brown recluse. c. tarantula. c( ) d( )
   b. trap-door spider. d. black widow.

3) If a customer called and complained of skin irritation and itching but cannot see any pest, you might expect: a( ) b( )
   a. flea larvae. c. brown dog tick nymphs. c( ) d( )
   b. mites. d. cockroach nymphs.

4) If a customer complains of "chigger" mite symptoms after returning from a camping trip, you would: a( ) b( )
   a. put down a residual treatment throughout the house. c( )
   b. treat the house and the customer with a pesticide.
   c. suggest the customer consult a physician and explain that these pests do not live indoors.

5) Upon finding an insect with forceps-like appendages on the tip of its abdomen, you would probably identify it as: a( ) b( )
   a. a centipede c. an earwig. c( ) d( )
   b. a termite soldier. d. an adult male cockroach.

6) During nest building, the English sparrow may block or plug drains and gutters and in this respect, may be considered a pest. T( ) F( )

7) Starlings are considered important predators of soil dwelling insects. T( ) F( )

8) The chief objection to starlings is that they tend to roost together thereby creating much noise and dirt. T( ) F( )

9) The droppings of bats and rodents differ in that those of bats contain chiefly insect fragments. T( ) F( )

10) In addition to creating noise and odor, bats in New Jersey are considered pests in that they frequently draw blood from pets and small children during the night. T( ) F( )

11) Although an animal is protected by law, if it becomes a pest, the applicator may destroy it without question or permit. T( ) F( )

12) Moles are rarely considered pests in that their tunnels are considered good aeration for lawns. T( ) F( )

13) Wharf borers feed in: a( ) b( )
   a. wet, soggy wood.
   b. dry wood.
   c. both of the above. c( )

14) The best permanent control for book lice is achieved by: a( ) b( )
   a. the use of residual sprays.
   b. the use of space sprays.
   c. correcting any moisture condition. c( )

15) Clover mites can best be controlled by: a( ) b( )
   a. spraying foundations, the house perimeter, and lawns with miticides.
   b. spraying baseboards.
   c. eliminating all clover. c( )

16) The best way to control millipedes is by: a( ) b( )
   a. spraying baseboards.
   b. spraying basements.
   c. spraying foundations and foundation plantings. c( )

17) To control Indian meal moth infestations in the home, the first thing to do is: a( ) b( )
   a. use a space spray.
   b. throw out infested materials.
   c. spray shelves with a residual insecticide. c( )

18) Cigarette beetles will infest: a( ) b( )
   a. spices, tobacco, and food products.
   b. only tobacco products.
   c. only spices. c( )

19) Black carpet beetle infestations: a( ) b( )
   a. must come from carpeting.
   b. could come from lint and hair accumulations in cracks and crevices.
   c. would most likely come from modern furniture. c( )

20) The main effort in earwig control is directed outdoors and includes removal or treatment of debris adjacent to foundations. T( ) F( )

21) A situation which signals a spring population of clover mites is: a( ) b( )
   a. a sudden early cold spell that lasts all winter.
   b. a very hot summer.
   c. a winter that starts mild and then becomes cold gradually with no warm spells.
   d. a winter that starts mild and becomes cold gradually with frequent warm spells. c( ) d( )

22) The best method of preventing a cricket infestation is to apply a barrier spray (or dust) from the base of the foundation outwards to a distance of ten feet. T( ) F( )

23) Human lice infestations should be: a( ) b( )
a. treated by an applicator. c. ignored.
b. referred to a physician. c( )

24) In the home, many stored product pests can best be controlled by first: a( ) b( )
a. sifting out adults from the stored product. c( ) d( )
b. dusting all the stored products.
c. removing and destroying the products.
d. fumigating.

25) Carpet beetles can be found damaging clothes, and clothes moths can be found damaging carpets. T( ) F( )

26) A common household pest which is a scavanger and can live most anywhere in the house is the: a( ) b( )
a. confused flour beetle. c. carpet beetle. c( ) d( )
b. cigarette beetle. d. cadelle.

27) The cigarette beetle is a pest only in tobacco or tobacco products. T( ) F( )

28) When webbing is found in insect-infested cereal, the pest is most likely to be: a( ) b( )
a. meal moths. c. carpet beetles. c( ) d( )
b. flour beetles. d. mealworms.

29) Carpet beetle damage to woolens and furs is done by: a( ) b( )
a. the adults. c. both larvae and adults.
b. the larvae. d. all life stages. c( ) d( )

30) If the cigarette beetle is a suspected pest in a household the most likely place to find the infestation would be the: a( ) b( )
a. bathroom. c. basement. c( ) d( )
b. bedroom. d. kitchen.

31) "Exclusion" is a control principle which prevents an animal from reentering a home or building by physically blocking its means of access. T( ) F( )

32) In attempting to exclude skunks and raccoons from a building, it is necessary to know whether the animal is nocturnal. T( ) F( )

KEY

1.	T	9.	T	17.	b	25.	T
2.	d	10.	F	18.	a	26.	c
3.	b	11.	F	19.	b	27.	F
4.	c	12.	F	20.	T	28.	a
5.	c	13.	a	21.	c	29.	b
6.	T	14.	c	22.	T	30.	d
7.	T	15.	a	23.	b	31.	T
8.	T	16.	c	24.	c	32.	T

RODENTS

1) The house mouse is more of a territorial animal than the Norway rat. T( ) F( )

2) In controlling rats, reducing the water supply will increase the effectiveness of: a( ) b( )
   a. solid baits.
   b. liquid baits.
   c. mechanical traps. c( )

3) Rodent damaged upholstering in a home is most likely caused by: a( ) b( )
   a. house mice.
   b. Norway rats.
   c. roof rats. c( )

4) The shape, size, and location of rodent droppings are useful in identifying the species. T( ) F( )

5) In cooler areas of the United States such as New Jersey the rodent which you would probably not find is the: a( ) b( )
   a. Norway rat.
   b. house mouse.
   c. roof rat. c( )

6. Locating smooth-sided rodent burrows about the diameter of a baseball below ground level would most likely indicate the presence of: a( ) b( )
   a. squirrels.
   b. house mice.
   c. Norway rats. c( )

7) The chief economic importance of most rodents has to do with: a( ) b( )
   a. damage done by gnawing supporting structures of buildings.
   b. the quantities of food they consume.
   c. the quantities of food they contaminate. c( )

8) Poison baits will be most effective in controlling rats if: a( ) b( )
   a. the sources of food can be significantly reduced or eliminated.
   b. they are placed out during the day.
   c. they are placed out during the evening. c( )

9) Rats will inhabit a building only if both water and food are available within the building. T( ) F( )

10) The reduction of available water is essential in controlling the house mouse. T( ) F( )

11) Spotting rats during the day usually indicates: a( ) b( )
   a. large populations and overcrowded conditions.
   b. that the rats wandered in the area by mistake.
   c. nothing since the rats are normally active at this time. c( )

12) House mice are more easily poisoned than rats because they eat an entire meal of one type of food in a short period of time. T( ) F( )

13) By changing the type of bait or bait location, your control may be more effective because of the inquisitive nature of the house mouse. T( ) F( )

14) A fairly successful rat clean-out will be effective for a number of years since the average life cycle of the rat is about 1 year. T( ) F( )

15) Skunks, raccoons, squirrels, and bats can often be best controlled by exclusion (closing entrance ways). T( ) F( )

16) In treating for a skunk or raccoon problem the time of day when the animal is active is an important consideration. T( ) F( )

17) Rats have poor sense of: a( ) b( )
a. sight.
b. smell.
c. hearing.
d. touch. c( ) d( )

18) The average distance rats travel from their nests is: a( ) b( )
a. under 5 feet.
b. 5-15 feet.
c. 50 feet or more. c( )

19) The average life span of a rat under field conditions is: a( ) b( )
a. 6 months.
b. 1 year.
c. 2 or more years. c( )

20) Signs of rodent activity include: a( ) b( )
a. footprints, droppings, and cast skins.
b. droppings, burrows, and rub marks.
c. urine stains, hair, and birth marks. c( )

21) The house mouse is usually active: a( ) b( )
a. at any hour.
b. at night.
c. during the day. c( )

22) Rats can cause a fire hazard by damaging the insulation on electrical wiring. T( ) F( )

23) Rats can spread from building to building through sewer systems. T( ) F( )

24) Which of the following rodenticides presents a significant secondary poisoning hazard? a( ) b( )
a. antu
b. pival
c. red squill
d. 1080 c( ) d( )

25) During a feeding, rats will generally eat: a( ) b( )
a. small amounts of a variety of foods.
b. a large amount of just one kind of food.
c. large amounts of a variety of foods. c( )

26) Which of the following rodenticides is not an anticoagulant? a( ) b( )
   a. diphacin
   b. zinc phosphide
   c. pival
   c( )

27) Which of the following does not need very much drinking water to survive? a( ) b( )
   a. roof rat
   b. house mouse
   c. Norway rat
   c( )

28) Traps are more effective in controlling house mice than rats because: a( ) b( )
   a. mice are smaller.
   b. mice stay closer to their nest.
   c. mice are more curious.
   c( )

29) Since mice travel long distances from their nests to forage, bait should be placed throughout the house. T( ) F( )

30) The best way to prevent rodent problems is: a( ) b( )
   a. to use good sanitation practices.
   b. to use an acute toxicant baiting program.
   c. to keep all doors and windows closed and locked.
   c( )

31) When using snap traps for rodents, place the trap: a( ) b( )
   a. perpendicular to the wall with the trigger toward the wall.
   b. parallel to the wall.
   c. perpendicular to the wall with the trigger away from the wall.
   c( )

32) Anticoagulant baits should be replaced periodically to prevent: a( ) b( )
   a. insect infestations
   b. mold growth.
   c. both of these
   c( )

33) For rats, pre-baiting is always necessary when using anticoagulants. T( ) F( )

34) 1080 is a very dangerous material to use for rodent control. T( ) F( )

35) Phosphorus paste on chocolate cookies is acceptable for mouse control in residences. T( ) F( )

36) The most effective and practical rodent proofing material is: a( ) b( )
   a. treated plywood.
   b. masonite.
   c. galvanized metal hardware "cloth".
   d. glass.
   c( ) d( )

37) Glue boards may be useful in controlling mice. T( ) F( )

38) Mixed anticoagulant baits are not considered very hazardous to humans because: a( ) b( )

a. humans are resistant to anticoagulants c( )
b. they cause humans to vomit.
c. a number of feedings are required.

KEY

1.	T	14.	F	27.	b
2.	b	15.	T	28.	c
3.	a	16.	T	29.	F
4.	T	17.	a	30.	a
5.	c	18.	c	31.	a
6.	c	19.	b	32.	c
7.	c	20.	b	33.	F
8.	a	21.	b	34.	T
9.	F	22.	T	35.	F
10.	F	23.	T	36.	c
11.	a	24.	d	37.	T
12.	F	25.	b	38.	c
13.	T	26.	b		

TICKS

1) The American dog tick is not a problem: a( ) b( )
   a. indoors. b. outside.

2) Which tick will normally not attach to people? a( ) b( )
   a. brown dog tick b. American dog tick

3) Ticks, like fleas, are insects. T( ) F( )

4) If a customer has a tick problem develop in the Fall of the year, it most likely will be the: a( ) b( )
   a. American dog tick. b. brown dog tick.

5) In brown dog tick control, the applicator should: a( ) b( )
   a. treat the premises as well as the dog.
   b. treat only the infestation in the house. c( ) d( )
   c. treat only the dog.
   d. treat all cracks and crevices in house, garage, sheds, and kennels.

6) The American dog tick is usually picked up by the dog: a( ) b( )
   a. at a boarding kennel. c. at the veterinarians.
   b. in a field or yard. c( )

7) Ticks can be: a( ) b( )
   a. vectors of human disease. b. are not known to be disease vectors.

8) Lawn and grass areas mowed regularly: a( ) b( )
   a. are usually infested with ticks.
   b. seldom have tick problems. c( )
   c. allow the tick's natural enemies to multiply faster.

9) It is generally unnecessary to treat outside the house when dealing with the: a( ) b( )
   a. American dog tick. b. brown dog tick.

10) If a residence is infested with ticks, should the dog be treated by the applicator at the same time as the residence receives a pesticide treatment? a( ) b( )
   a. Yes b. No

11) If a customer gives you a tick with white mottled marks on the area behind the head, it is most likely the: a( ) b( )
   a. lone star tick. c. American dog tick. c( )
   b. brown dog tick.

12) The applicator need only be concerned with treating the adults since ticks feed only once during their life cycle. T( ) F( )

T2

13) Larval or "seed" ticks have: a( ) b( )
   a. no legs.
   b. 6 legs.
   c. 8 legs. c( )

14) When treating for the brown dog tick, a good chemical control procedure outside the infested residence is usually necessary to prevent reinfestation. T( ) F( )

15) The brown dog tick normally feeds on: a( ) b( )
   a. cats.
   b. dogs.
   c. humans.
   d. all of the above. c( ) d( )

16) A "clean" dog is likely to pick up brown dog ticks by directly contacting an infested dog. T( ) F( )

17) In New Jersey, the tick most likely to be treated by pesticide applicators is the: a( ) b( )
   a. American dog tick.
   b. brown dog tick.
   c. Oriental dog tick. c( ) d( )
   d. lone star tick.

KEY

1. a	7. a	13. b
2. a	8. b	14. F
3. F	9. b	15. b
4. b	10. b	16. F
5. d	11. c	17. b
6. b	12. F	